ALTERNATIVE PAYMENT SYSTEM FOR MODERN PUV

A Thesis
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Information and Communications Technology Program
STI College Balagtas

In Partial Fulfilment
of the Requirements for the Degree
Bachelor of Science in Computer Engineer

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ABSTRACT

Title of research**:** **Alternative Payment System for Modern PUV**

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This capstone project aims to offer a convenient and modernized fare transaction system for commuters traveling along McArthur Highway, from Calumpit to Meycauayan in Bulacan. This RFID-based device is designed for cashless payment in Chatco Company's Modern public utility vehicles (PUVs), allowing passengers to select their destination upon tapping their card. The device will record both the origin and destination, then compute the corresponding fare. For the system structure, the developers use the Python Language for GUI (front end) Java Language that will run on the Springboot (back end) and Mongo DB for the system's database. For the hardware structure, Microcontroller module (Raspberry Pi 4 model B) is installed on the modern PUV, with the RFID, GPS receiver, and Mini Thermal Printer all connected to it. The system employs a smart card for transactions, utilizing Radio Frequency Identification (RFID) technology for data storage and transfer. GPS receiver acquires the coordinates of Modern PUV, to be able for the device to perform computations. A Mini Thermal Printer is used to generate and issue receipts. All transactions will be transmitted to the database server.

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INTRODUCTION

In the Philippines, public vehicles are preferred by the majority of people because of their accessibility and ease, and jeepneys are a common mode of transportation for commuters. The Public Utility Vehicle Modernization Program (PUVMP) is one of the many initiatives the Department of Transportation (DOTr) has been implementing to address issues pertaining to transportation while also meeting the demands of rapidly evolving technology. This program has been issued in 2017 under Department Order (D.O.) No. 2017-011 or the Omnibus Guidelines on the Planning and Identification of Public Road Transportation Services and Franchise Issuance or the Omnibus Franchising Guidelines (OFG). In addition, the modernization program shall set in place a standard to optimize the advantages offered by modern jeepneys throughout the nation. All jeepney engines should at least be Euro-4 and PNS- (Philippine National Standards) compliant engines or LPG-powered, electronic, and hybrid. Having GPS, an automated fare collection system and a CCTV camera are other features to look for to be considered as a modernized jeepney.

As technology develops, innovative transportation practices like the usage of cashless payment methods are becoming extensively used. According to Caya, et al. (2021) due to the pandemic and new normal, the use of cashless methods instead of paper money is unavoidable, this is to prevent direct contact of people in the spread of the Covid-19 virus, in the future. Along with the advancement of jeepneys is the introduction of the Automated Fare Collection (AFC) System in transportation which is a generic term for a ticketing system in public transport where the fare is no longer paid directly but via ticket vending machines, online services, or other methods. In practice, AFC is the default fare collection method in any modern public transport system.

With the rise of the given advancements, the government wants to utilize these and make the country grow. Senate Bill No. 2533, also known as the "Public Utility Vehicle Cashless Payment Act," was filed by Senator Grace Poe in the 18th Congress of the Philippines. The bill seeks to require all public utility vehicles (PUVs) in the country to adopt cashless payment systems. The bill was passed by the Senate on the third and final reading on January 30, 2023. The bill aims to promote the use of cashless payment systems in the PUV

sector, which would help to reduce the risk of cash handling as well as transmission of diseases. Improve the efficiency and convenience of commuting. Make it easier for commuters to track their expenses and reduce the risk of fraud and corruption. The bill also mandates the Land Transportation Office (LTO) to establish PUV cashless payment system (CPS) standards and guidelines. These standards and guidelines would cover the following areas: The types of cashless payment systems that can be used. The technical specifications of the cashless payment systems. The fees that can be charged for using cashless payment systems. The process for resolving disputes between commuters and PUV operators. The LTO would also be tasked with conducting a public information campaign to educate commuters about the benefits of using cashless payment systems. The bill is currently in the House of Representatives. It is unclear when the House will vote on the bill.

According to Bwigenge, et al. (2020) the effectiveness of cashless payments, increases economic factors and also benefits commuters and operators, such as the easy way to collect fares, reduce inconvenience of carrying cash, especially changes, and promote road safety. As the number of modernized jeepneys continues to rise, the number of AFCs being used also increases and people become familiar with this payment method. According to the Undersecretary for Road Transport and Infrastructure Mark Steven Pastor, He said that such a method will help bring convenience to the riding public. The institutionalization of the AFCS will bring us closer to the goal of achieving global standards in cashless payments when commuting, following the norm in many other countries that have long been using this system. But the problem is in rural areas. The modern jeepney company implements AFC but they are more inclined to use a POS system that leads to using cash. The use of said system neglects the use of the cashless payment method of AFC and has inaccurate fare payments where the fare matrix is not properly followed. As a result, the researchers aim to develop a device where these problems and unfair scenarios can be solved while making the company, operators, and conductors, as well as the passengers, get what they deserve. The device is expected to work with the cashless transaction and compute the precise and accurate fare while taking the fare matrix into consideration.

Background of the problem

In traditional jeepneys, despite being popular in terms of transportation with a total of 40%, and an estimated 40 million people riding per day (Mariano, 2020), a payment system must be eligible. Paying the minimum fare every four kilometers and the precise fare distance for each place, individuals may also be unsure of how much or precisely the fare should be paid at a particular location, as well as the discounts that should be applied to each fare.

There are countless complaints about irregularities regarding the fare of MPUV. According to Kaiser Jan Fuentes (2023), a person from local news, a passenger who was traveling the same distance and route in two MPUVs owned by different operators was charged with different fares by the conductors or passenger assistance officers of those vehicles recently. This proves that there is a problem with how the fare is computed. In the same report, LTFRB 7 Director Eduardo Montealto Jr. said that not following the fare matrix is unlawful and violators will face penalties. He also said that the public can help end this practice by filing a formal complaint at their office, which will allow them to take action against violators. However, the complainants are hesitant to report such incidents to their office because it will eat up their time. As a result, there are injustices about fare that are left unsolved and unnoticed.

In the proposed alternative payment system, the passengers do not have to carry so much cash, especially coins when riding the modern jeepney. The change will not be a problem and no one will be penalized for the wrong-charged fare. There is an ongoing transition from traditional jeepneys to modern jeepneys, might as well use this opportunity to change the traditional fare system and catch up to the other countries that are now using effective fare systems.

Overview of the current state of the technology

The fare collection system that exists in traditional jeepneys starts with the driver asking for your destination and based on your origin, the driver itself will compute what he thinks is the exact fare which is the reason why the payment transaction is poor and slow. This may also cause a loss in revenue for the driver or the overpayment of passengers. Not until

the implementation of jeepney modernization that AFCS or Automated Fare Collection System was introduced. AFCS was first used in trains and buses a long time ago, but its implementation on traditional jeepneys was left behind because AFC is simply not compatible with it.

AFCS is a technological advancement that has completely changed how people pay for transportation. By taking away the need for manual ticketing and payment systems. Smart cards, ticket vending machines, and fare gates are some of the parts that make up the AFCS. Together, these elements function completely to give passengers a quick and easy payment experience. A passenger just needs to tap their smart card when they enter a fare gate to deduct the fare from their account. Passengers can purchase and top up their smart cards at ticket vending machines, and transit operators can keep an eye on things from a central control center. Having AFCS is another step to innovation and solves many issues about fare collection since it will be cashless and manual computation is now done by the device.

In modern jeepneys, the difference is that, instead of fare gates and fare media, POS terminals are currently used by the company to collect fares. Although these terminals accept smart cards, the device also accepts cash transactions, which is why passengers neglect the use of smart cards and settle for cash. Because of that, the problem with cash transactions starts to rise again like the estimation of change that leads to not following the fare matrix. Since POS terminals have fixed buttons for origin and destination, another problem is that the distance will not be accurate since conductors have to estimate the distance in kilometers that the passenger travels before giving the fare ticket.

To solve this problem, the researcher will make a device that computes the accurate or close to the exact distance between the location of origin and destination. With that, the problem with the unfair computation of fare will also be solved since the device will be the one to do the work.

Objectives of the study

The capstone project aims to provide a cashless transaction system in modern jeepneys and help passengers adapt to it by innovating an alternative way of paying and collecting fares.

Specific Objectives

1. **To develop a module that would provide fare computation based on distance traveled.**

   - The device will be able to compute the fare using the GPS module that will identify the distance traveled by the passenger based on its origin and destination. Initially, the device will determine the passenger's origin after tapping its card and the destination will be chosen by the passenger, then the device will provide a receipt for the fare. If the passenger exceeds or gets off early based on its destination, the device will compute another transaction for the total distance that the passenger actually traveled.

2. **To develop a module that will improve digital payments using the provided RFID.**

   - To pay for the fare in modern jeepneys the passenger should use a card that has load or credits on it. Every time the passenger pays using the card, the fare will be deducted from the credits stored within. If the credits are insufficient to pay for the fare, the device is capable of reloading the card starting from 20 and above. The RFID improves the payment system because the deduction of fare will be exact and without estimation.

3. **To develop a module that will give exact discounts to eligible passengers and where it is due.**

   - The device can determine if the card is regular or discounted. If the card is discounted, 20% of the fare will be automatically deducted from the fare of students, PWD, and senior citizens who are eligible to receive the discounts. The card will have different colors to determine if the discounts are used properly. RED for regular cards, blue for students, white for PWDs, and yellow for senior citizens.

4. **To develop a system that will save all the transactions made with the device, time in and out of the conductors and drivers, and the beginning and end of the trip.**

   - The server will save all the records of the loading and paying of fares done within the device to be processed by the company. The conductors and drivers will need to tap on the server to serve as their attendance and for them to have the device assigned to them for that day. Determine if the modern jeep has already made each trip and the beginning and end of the shift.

Scope and limitations of the study

This capstone project is about developing an RFID-based device for cashless payment in modern PUVs of Chatco Company, specifically for commuters traveling along the McArthur Highway from Calumpit to Meycauyan in Bulacan. It aims to innovate payment transactions and provide a convenient way for commuters to pay fare costs.

The shift will begin when the device is distributed to the operators only by the person in charge. The conductor will tap the master key on the device to record their time-in for attendance, then select the spare change. The driver will tap the master key on the device to record their time-in for attendance and will select the bus number. The master key is issued to the rightful owner and is used to identify the assigned partner and the jeep number.

Following the start shift process, the jeep will leave according to the schedule and interval that specify who will leave first. If the conductor or driver is late, they will be penalized and will have to wait until the first five jeeps have left before it is their turn to leave.

The process of tapping in and out will start when a passenger boards the jeepney. They will tap his/her smartcard on the device to check their balance and recognize its origin, then the device will show the list of destinations based on the provided station, and the passenger will choose their destination for the device to compute the fare then tap again to pay for the computed fare. Upon reaching at their destination the passenger will tap out at their destination. If the passenger leaves early before their destination or extends their intended destination, they need to tap again in the device to make a new transaction and compute the fare once again to deduct the right fare. If the balance is not enough to pay for the fare, the device can also reload the smart cards, but it is not advisable and must only do if necessary.

The process of loading and change route begins with the master key being tap into the device. If the conductor choose the load, the passenger will select the amount for load then the passenger will tap again to confirm the transaction, and a receipt will be printed. If the conductor selects Change Route, the conductor will submit the change route, and a receipt for all previous transactions will be printed.

There will be two types of cards, the regular and the discounted card which will be used as the main mode of transaction and contain a value that can be used as a fare. For regular cards which are colored blue, they don't have any discounts. For the discounted cards, there are types of cards that have different colors. Red for students, white for PWD, and yellow for senior citizens. The fare will be discounted by 20% based on the law if any of the discounted cards are used. The provided smart cards and their credit only work for the device and its system

The end of the shift will happen after completing three trips, the conductor will initiate the end shift process on the device, which will print a summary of the total transactions, including the names of the driver and conductor, date and time, and any incentives earned for reaching a certain amount of fare collected then the conductor will remit the money that they have collected for that day and then they will tally the total amount that they have collected in the load transaction. The device will automatically reset its data for the day.

The device can load the cards while on a trip. When the conductor taps his master key into the device, an interface with options for loading and changing routes will appear. If the conductor clicks on loading, the passenger will select how much money he/she will reload. Finally, the passenger will tap his/her card to complete the transaction, and the device will provide a receipt as evidence of the reload transaction.

Limitations:

- The system cannot determine if the smart card is used by its rightful owner.
- In a situation where the passenger only has cash as a payment, the conductor cannot accommodate the passenger since the device only works in a cashless transaction using the provided smart cards.
- The malfunctioning of the device while on a journey.
- When the device loses internet connection while on journey.

LITERATURE REVIEW

Review of related literature, studies or systems

According to Quismorio (2022), The goal of House Bill (HB) 4913, commonly referred to as the "Universal Beep Card Bill," is to eliminate the trouble and needless expenses associated with using many contactless smart cards or beep cards by implementing a one-card-fits-all system for public transit in Metro Manila. Vargas, a member of the House Committee on Metro Manila Development, stated, "We remove barriers of expensive and unnecessary costs of public transportation by centralizing stored-value payments and transactions into a 'universal beep card'. Reloadable contactless smart cards known as "beep cards" were first launched in 2015 as a means of paying for rail-based fast transit services in Metro Manila. These services include Light Rail Transit (LRT) Lines 1, 2, and 3, as well as some bus lines. But in 2016, a new contactless smart card was introduced for the Bagong Jeep (BEEP) program, a public transportation initiative that was introduced in Metro Manila concurrently with the national government's Public Utility Vehicle Modernization Program (PUVMP). The riding public has become so perplexed by this needless division that the Department of Transportation (DOTr) was forced to issue a statement in 2020 outlining the distinctions between the two smart cards. As long as it complies with the DOTr's requirement to use contactless transactions in public transportation, PUV operators are free to select the automatic fare collection system (AFCS) that they will use for their operations.

The main objective of this study was to examine the feasibility of introducing a smart card system in the Philippines to enhance the fare payment matrix in public transportation providers and assess its effects in order to theoretically address problems related to the escalation of urban traffic congestion, irregularities in the fare matrix's implementation, and requests for PWD, student, and senior citizen discounts that are made without discrimination. Data was gathered using a survey questionnaire, and 300 research participants were selected using snowball purposive sampling. These participants included public transportation operators and drivers, as well as passengers who were classified into

four (4) categories: regular, student, Person with Disabilities (PWD), and senior citizens. A paradigm shift is occurring to enhance public transportation services and utilities in the Philippines by implementing innovations like smart cards. Given the favorable reaction to commuters' adoption of smart card use (73%) and encouraging cashless transactions (72%), it would be more convenient for senior citizens, PWDs, and students to benefit from a reduction with the help of modern technology (71%). (Bustillo, Cendana, & Palaoag, 2017)

According to Visa's Consumer Payment Attitudes Study (2022), cashless payments are on the rise in the Philippines, with 60% of Filipinos carrying less cash in their wallets and 84% having attempted to go cashless by 2021. "While cash is still commonplace in the Philippines, the preference for cashless payments is clearly gaining momentum," said Dan Wolbert, Visa's country manager for the Philippines and Guam. As cashless payment methods expand, our study found that more Filipinos felt confident to go without cash for longer periods of time, with more than half feeling confident to go without cash for a week or longer."

According to Ampah (2018), due to the growing popularity of smartphones, mobile web applications, and internet access, Ghana's economy has seen significant growth in a number of sectors, including health, education, and finance. And for that Ghanaian people find the implementation of NFC and QR codes technology in the country's cashless payment system a useful and convenient tool for transportation needs. In addition to the identification cards they already own, the system requires the user to register and pay for a card. A cashless mode of payment for transportation would not only be more convenient, but it would also help stabilize transportation costs while in transit. It also enforces driver accountability and discourages theft because the transport owner can view the transaction.

According to Pawar (2020), a cashless society is an economic state where financial transactions are conducted through digital information, typically electronic representations of money. This transition has existed through barter and other exchange methods and has become possible using digital currencies like bitcoins. India's government, led by Prime Minister Narendra Modi, launched the Cashless India mission to reduce the country's dependency on cash and bring unused black money into the banking system. The demonetization of old currency notes in 2016 marked the beginning of this transition.

To speed up boarding, collect data, and reduce costs, a number of US transit agencies intend to automate their fare collection and reduce or perhaps entirely eliminate the use of cash fares. But the problem is 10% of US adults lack bank accounts or credit cards, and most of them are dependent on cell phone data plans or do not have access to the internet or a smartphone. We found out that roughly 30% of passengers use cash when riding buses at the time. Many of these passengers believe they could find other ways to pay with cash if on-board cash fares were eliminated, but many also think they would still use cash in other contexts (e.g. at retail or ticket vending machines) (Golub et al., 2022).

Synthesis

This study does not attempt to duplicate the work of others; rather, its goal is to adopt and enhance a cashless payment system substitute for Modern Jeepneys. House Bill 4913, also known as the Universal Beep Card Bill, seeks to establish a one-card-fits-all public transportation system for buses and LRT in Metro Manila, utilizing smart cards or beep cards for contactless technology Quismorio (2022). Implementing a smart card system in the Philippines is to improve the fare payment matrix used by public transportation providers and evaluate its impact to theoretically address issues with the increasing level of urban traffic congestion, irregularities in the application of the fare matrix, and requests for nondiscriminatory discounts for PWDs, students, and senior citizens.

To outline the aforementioned points, the effectiveness of cashless payment systems has had a significant influence on the economy, with the use of smart cards as payment for faster transactions and convenience for passengers. The researcher would like to apply these ideas by proposing a device that will make use of cashless transactions that will help ease the convenience of the passengers. Integrate modules that can display the user's needed information after tapping the card, a feature that resets the balance if the passenger leaves early or extends the destination and a new fare will be made, reload cards if it is insufficient, and tapping out the card that will end the transaction record.

ALTERNATIVE PAYMENT SYSTEM FOR MODERN PUV

Overview of the project

This project consists of a device that will innovate the idea of "commuting" among passengers by introducing electronic payment using RFID technology. This device can store information about the transaction of payments, and the time in and out of the driver and conductor. This device can determine if the passenger exceeds or gets off early based on its destination and correct the transaction based on the distance traveled. The developers will be using a prototype concept model as a methodology to develop a prototype. Which will be tested and improved until the desired function of the device is achieved.

Planning

The researcher will conduct a survey to the passengers of the modern jeep to know their experience paying in cash and their opinion about the current fare system. We will also get the opinions of the Modern Jeepney Company through interviews to know what the current fare system they use is. After collecting the information, the researcher will develop a device that may provide a convenient payment system for commuters.

Initial Requirement

This is the process of surveying and interviewing on why the system must be developed. The researcher will use the information collected from the survey to create the system design of the project.

Design

In this process, the researcher shows the entire block diagram and flow chart pertaining to the functionality of the device. *(See Appendix A - Figure 1-6)*

Development

The researcher will develop a design based on the gathered data, a device that can get the coordinates of the modern jeep for the place of origin using GPS module, RFID for payments, communication of main device and server, server for utilizing the list of transaction as well as logging in of the conductor and driver.

Prototyping

The researcher will provide a prototype device consisting of Raspberry Pi 4 model B as the core and microprocessor and utilize the combination of different kinds modules, the RFID for fares, the GPS for coordinates, the LCD Screen as monitor, the Wi-Fi module for sending and receiving data and the Mini Thermal Printer for receipt with the help of Python as the main programming language and API for exchange of information of server and the device.

Testing

In this process, the researcher will test the system if the modules are working simultaneously. Also, this process will help the researchers identify any potential problems that the system may have.

Maintenance

In this process, the researcher will maintain the stability and durability of the device. To avoid unnecessary problems that may occur, and to provide a smooth transaction in terms of alternative fare systems.

System design specification

This section should contain an explanation of how the system is put together.

RFID Module

RFID systems rely on readers, writes, and printers for processing and intelligence. These devices, often powered passively or from small batteries, form the basis of any RFID system. They connect to a back- communicate with RFID tags: readers and writers, which transmit data to and from tags, and transceivers that combine them for two-way communication. RFID technology allows flexibility in the placement, as the line of sight is not required. Barcode systems require a line-of-sight path, requiring items to be visible and orientated for reading. This component enables the device to examine the details of each passenger's card and send data to the server. It also deducted the passengers' fares and loaded their smart cards office or remote controlling system for operation monitoring. *(See Appendix D – Figure 7. RFID module)*

Microcontroller (Raspberry Pi 4 model B)

This version of Raspberry Pi (v4) was released In June 2019, featuring a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor, onboard 802.11ac Wi-Fi, Bluetooth 5, full gigabit Ethernet (throughput not limited), two USB 2.0 ports, two USB 3.0 ports, 1, 2, 4, or 8 GB of RAM, and dual-monitor support via a pair of micro HDMI ports. It's better than the other version because of its two micro-HDMI ports that support dual 4k displays; it is perfect for multimedia and productivity tasks. Although it is more expensive than other types of microcontrollers, the Raspberry Pi v4 is suitable for our gadget in terms of specifications and quality, as well as its functions. It can also conduct and read data via API and any computer language, including Python, which we will be employing for our project. The Raspberry Pi is popular for learning to code, circuits for physical projects, and home automation projects, making it accessible to the open-source community. This system hardware is the device's primary body; Raspberry Pi enables us to learn programming languages and network administration, which will compute the fare and receive data from RFID, and deliver it to the server. *(See Appendix D - Figure 8. Raspberry Pi 4 model B)*

Mini Thermal Printer

With this thermal printer, you can add a tiny printer to any microcontroller project. They are what you see at the ATM or grocery shop, and are also known as receipt printers. You can now incorporate your own personal printer into an enclosure. This printer is great for communicating with a microcontroller; all you need is a 3.3V to 5V TTL serial output from your microcontroller to print text, barcodes, bitmap pictures, and even a QR code. It can print barcodes in the following standard formats: UPC A, UPC E, EAN13, EAN8, CODE39, 125, CODEBAR, CODE93, CODE128, CODE11, and MSI with adjustable barcode height. This printer will produce receipts/tickets for passenger fare payments; it includes the traveler's origin and destination, date and time, as well as the amount of their fare. *(See Appendix D - Figure 9. Mini Thermal Printer)*

GPS Module

The Global Positioning System (GPS) is a satellite navigation system that gives location and time information in all-weather circumstances to any place on or near Earth that has an unobstructed line of sight to four or more GPS satellites. It is maintained by the US government and can be accessed by anybody with a GPS device. Originally designed for military usage, it was made accessible for public use in the 1980s with no subscription or setup fees. A GPS receiver determines its position via a process known as satellite ranging, which includes measuring the distance between the GPS receiver and the GPS satellites that it is tracking. This is compatible with a variety of flight controller modules that include GPS computer testing software. Innovative design and technology suppress jamming sources and mitigate multipath effects, resulting in exceptional navigation performance even in the most difficult conditions for NEO-6M GPS receivers. This methodology assists us in locating the passenger's origin and destination, as well as providing some information to the reader if the passenger rode and arrived at their desired destination. *(See Appendix D - Figure 10. GPS module)*

On/Off Switch

When the job of a control is to open or close an electrical circuit in a stable manner, it is defined as an on-off switch. A momentary on-off switch or push-button on-off switch, also known as an on-off push-button, is one that closes or opens in a non-stable or momentary manner. The push-button is used to open or close an electrical circuit in a non-stable or transient manner. This indicates that the button will open or close as long as pressure is applied to it. In the case of the on-off switch, the button with the I/O marking is used to permanently turn on or off any equipment until a new instruction is issued. *(See Appendix D – Figure 11. On/Off switch)*

Touchscreen LCD display

LCD (Liquid Crystal Display) is a flat-panel display that operates with liquid crystals, replacing light-emitting diode (LED) and gas-plasma displays. Because it blocks light rather than emitting it, it enables for thinner displays and requires less power. Unlike LEDs, which emit light, LCDs produce images using a back light. As LCDs phase out older technologies, other technologies such as OLEDs emerge. The Global Positioning System (GPS) is a satellite navigation system that offers precise location and timing in all-weather circumstances. Originally intended for military usage, it was made available to civilians in the 1980s with no subscription or setup fees. It is the face of the device that displays information about fares, origin & destinations, balance, and etc. *(See Appendix B – Figure 12. Touchscreen LCD display)*

Buzzer

A buzzer is a mechanical, electromechanical, or piezoelectric (piezo for short) audio signal device. Buzzers are commonly used in the industry as alarm devices, making a buzzing or beeping noise when there is a requirement for buzzing. A buzzer is a type of voice device that translates an audio model into a sound signal. Its primary function is to prompt or

alarm. It may generate music, flute sounds, buzzers, alarm sounds, electric bells, and other sounds according to the design and application. This page discusses buzzer selection and operation. Typical applications include sirens, alarm devices, fire alarms, air defense alarms, burglar alarms, timers, and so on. It is widely utilized in household appliances, alarm systems, automatic production lines, low-voltage electrical equipment, electronic toys, and other applications. This will be used to identify if the tapping of the card is successful and to notify the passenger if they tap out early, extend their destination, or just at the right destination depending on the sound that the buzzer will produce. *(See Appendix D – Figure 14. Buzzer)*

Software Architecture

API is an abbreviation for Application Programming Interface. APIs are mechanisms that allow two software components to communicate with one another by defining and enforcing a set of rules and protocols. In the context of APIs, the term Application refers to any software that performs a specific purpose. Interface can be viewed as a service contract between two programs. This contract specifies how the two will communicate with one another via requests and responses. Their API description explains how developers should organi**ze** those calls and responses. MongoDB is a NoSQL database system that uses a document-oriented data model to store information in flexible, JSON-like documents called BSON (Binary JSON). Unlike traditional relational databases, which rely on structured tables with predefined schemas, MongoDB allows for a dynamic schema where the structure of the data can evolve over time. This flexibility is ideal for handling unstructured or semi-structured data, making it well-suited for modern applications that require scalability and adaptability. MongoDB offers features like horizontal scaling through sharding, which distributes data across multiple servers, and powerful querying and indexing capabilities to efficiently manage and retrieve data. Its design supports high performance and easy scalability, making it a popular choice for applications that handle large amounts of diverse and evolving data.

The researchers will use MongoDB as the database of the device, that will send and store data within the server, this will ensure that all information and data including date, time, origin, destination and total fare collected by the device is efficiently managed sending to the server, stored and can be easily accessed.

Docker is a platform that allows developers to package applications and their dependencies into isolated, lightweight containers, ensuring consistent performance across different environments. It is efficient, faster than traditional virtual machines, and widely used in modern software development, especially for micro services and cloud-native applications. The researcher will use Docker to run applications in isolated containers such as MongoDB, making it easier to manage and deploy software on the limited resources of an RPI.

Python is a popular computer programming language used for creating software and websites, task automation, and data analysis. Python is a general-purpose language that may be used to develop a wide range of programs. Python is a high-level, interpreted, object-oriented language with dynamic semantics. Its dynamic typing and dynamic binding, along with its high-level built-in data structures, make it an appealing language for Rapid Application Development and for usage as a scripting or glue language to join existing components. Because of its straightforward, basic syntax, Python promotes readability, which lowers software maintenance costs. Python's support for packages and modules promotes code reuse and program modularity. The large standard library and the Python interpreter are freely distributable and accessible for free on all major platforms in source or binary form.

The researchers will be used Python programming language to program the system of the device, it will program the necessary information and computation to process the system of the device correctly.

RESULTS AND DISCUSSIONS

This section examines the modules and components that are needed for the project that could have a significant effect on its overall function and performance. The researchers evaluate each component with multiple testing to find out how it works and how to utilize their function to achieve the objective of the project.

Hardware Testing

The researcher tests all of the hardware modules and components to make sure that it works as desired and goes with the standard. The result of the testing is by then analyzed carefully and thoroughly.

RFID Module Testing

The researcher chooses the best RFID module for the project by considering its size and overall performance. A radio frequency identification module composed of an antenna that produces a high frequency electromagnetic field serves as a reader. On the other hand, tags are typically passive devices that is, they don't require batteries. It is composed of an antenna for receiving and sending signals, as well as a microchip for processing and storing data. A tag or card that needs to be identified and a reader that scans the tag make up the two primary parts of an RFID, or radio frequency identification module. In the market the MFRC-522 13.56MHz RFID Module is the best option since it is easy to use and can be easily interfaced in a system using its libraries in python. Using this module the researcher will be able to digitalize the payment system. The researchers test this module by connecting the pins to the Raspberry pi and then run some code to verify its function. *(See Appendix D – Figure 22)*

Table 1. RFID Module Testing

Test No.	Setup	Result	Solution	Remarks
1	RFID Module with Microcontroller	Can't install the needed libraries (MFRC522)	Searching for other way to install the libraries.	**FAILED**
2	RFID Module with Microcontroller	Can't run the code cause the libraries are not working	Try to install it manually using Github repository	**FAILED**
3	RFID Module with Microcontroller	Running the code, reads the card and write on it.	Try to install using pip in a Virtual Environment	**SUCCESSFUL**

Microcontroller

The developers chose the Raspberry Pi 4 Model B due to its specifications and quality, which will be suitable for the device. A microSD card is inserted, serving as the storage for the Raspberry Pi in able to run the operating system. After downloading and unzipping the OS files by choosing the extract all, the developers download the Win32DiskImager.exe software to write the Raspbian image to the SD card so the SD card can be used in the Raspberry pi. After all the instructions the developers successfully rebooted the Raspberry Pi using provided code to start testing their device. The researchers test the microcontroller by inserting the connection wires to its corresponding ports, HDMI is connected between the LCD touchscreen and the microcontroller serves as the connection. The keyboard and mouse connected to the microcontroller, serves as the interaction. Finally, once the power supply is plugged in, it provides electricity for all the components to function. This allows the Raspberry Pi to operate successfully. As a result, the operating system will appear on the LCD touchscreen that has been connected, enabling it to interact with the Raspberry Pi using the touchscreen, keyboard, and mouse. *(See Appendix D – Figure 10)*

GPS Module Testing

The developer employed a NEO-6M GPS module with Raspberry pi 4 and Thonny Python IDE to gather the coordinates and accurate data. GPS also provides navigation systems to show vehicle current locations and trip history. *(See Appendix D – Figure 20-21)*

Table 2. GPS Module Testing

Test No.	Setup	Results	Solution	Remarks
1	GPS module with RPI v4, Thonny (Python IDE)	The output longitude and latitude did not display.	Search for more information and solutions	**FAILED**
2	GPS module with RPI v4, Thonny (Python IDE)	It shows the correct output and coordinates	Changes of commands. Needed to an open area to give the coordinates fast.	**SUCCESSFUL**

LCD Touchscreen Testing

The researcher uses a 7-inch touchscreen LCD (Liquid Crystal Display) which enables users to interact directly and display output for microcontrollers, with common interfaces that connect touchscreen to a device include HDMI, USB, and GPIO. This serves as the face of a device which displays data and information about the total fare and balance, origin and destination, date and time, and etc. *(See Appendix D – Figure 18)*

Table 3. LCD Touchscreen Testing

Test No.	Setup	Results	Solution	Remarks
1	LCD with microcontroller	Slightly error correction in display, can't sync in touch properly.	Need to reboot to sync in touch.	**FAIL**
2	LCD with microcontroller	Can configured screen/display orientation.	Changed the orientation	**SUCCESSFUL**

Buzzer Module Testing

The developers used the Grove-Buzzer 107020000, a 5V piezoelectric buzzer for notification purposes, to notify passengers of successful or unsuccessful card tapping and transaction depending on the device's sounds. *(See Appendix D – Figure 23)*

Table 4. Buzzer Module Testing

Test No.	Setup	Result	Remarks
1.	Buzzer with RPIv4	The buzzer performs as expected with a different sounds depending on the provided code.	**SUCCESSFUL**

Mini Thermal Printer Testing

The researcher used a mini thermal printer to print receipts/tickets containing passenger's origin and destination, date and time, balance and the amount of their fare. *(See Appendix D – Figure 25)*

Table 5. Mini Thermal Printer Testing

Test No.	Setup	Results	Solution	Remarks
1	Mini Thermal Printer with RPI v4	The printer prints the sample receipts effectively.	Edit code to adjust size and format.	**SUCCESSFUL**

Software Testing

API (Application Programming Interface)

API are essential for exchanging data from databases because they offer a standardized and optimized means of communication between various software systems. They make it possible for developers to carry out operations like data querying, updating, and deletion without having to fully understand the underlying database architecture because they abstract the complexity of database operations. Additionally, APIs offer real-time data exchange for synchronization which is the goal of the project. The researchers find it hard to use an API to exchange information from the databases. There are still parts that we can't understand, especially how the software works which is needed to use API. The researcher already installed MariaDB, Mysql, and pyodbc which we think is needed for using API but it seems that we are not making any progress when it comes to testing. The researchers are still in the phase of finding how it works and how to use it for our goal.

Python

The developers chose an appropriate programming language for their needs: Python. Utilizing Thonny, a highly efficient and easy to use Integrated Development Environment (IDE), is an efficient and easy to use IDE for executing commands in each module. Python stands out as the best language for automating tasks and conducting data analysis; it is a highly versatile programming language that can be used for both simple and difficult

assignments, such as the developer's project. The Thonny Python IDE tool is running properly since each module is tested with Python codes and commands. The developer required Python for Graphical User Interface (GUI) to produce simple data visualization and map plotting. The developers also decided to try Visual Studio Code to test the different module components constructed with Python.

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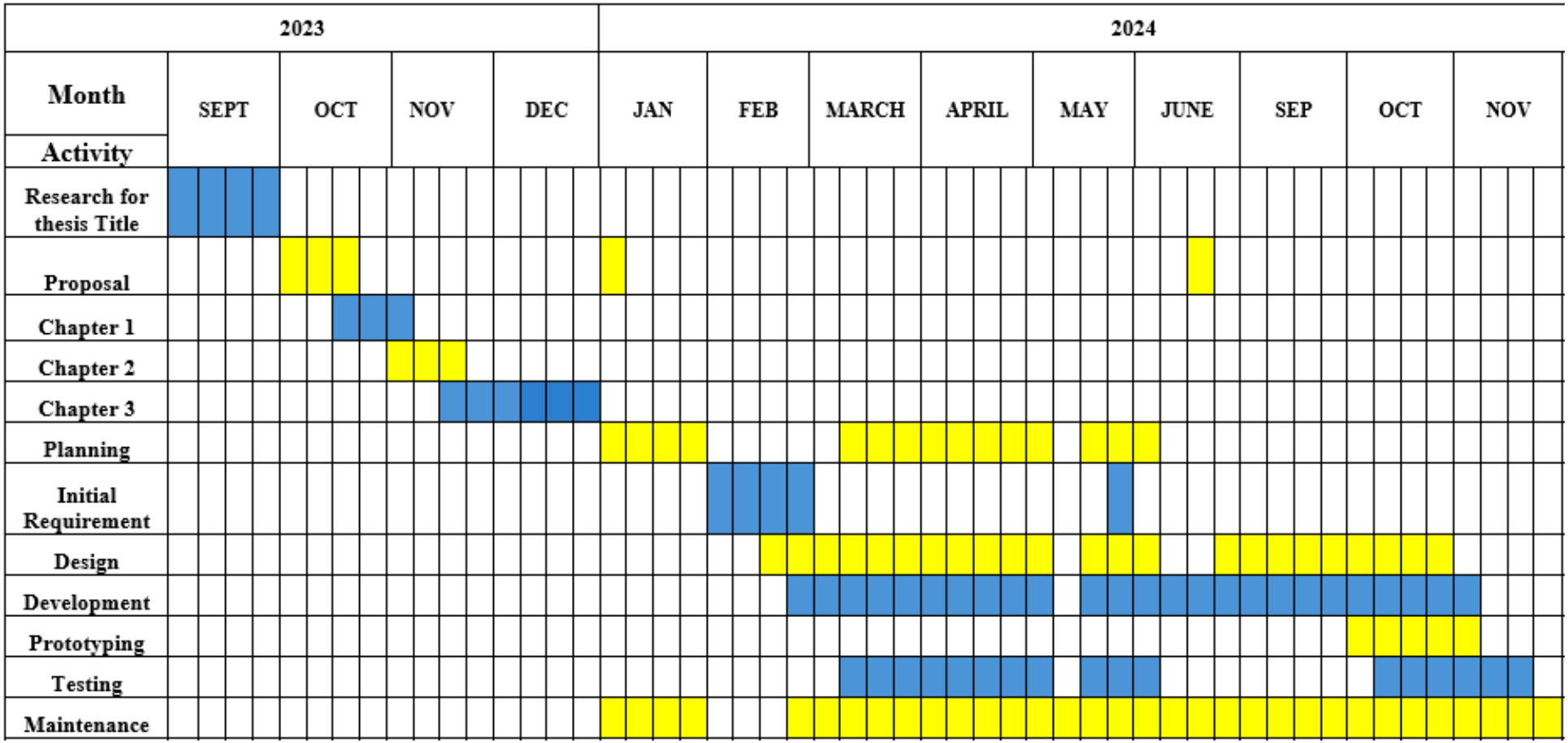
APPENDICES

APPENDIX A. GANTT CHART OF ACTIVITIES

GANTT CHART


2023
2024
Month
Activity
SEPT
OCT
NOV
DEC
JAN
FEB
MARCH
APRIL
MAY
JUNE
SEP
OCT
NOV
Research for thesis Title
Proposal
Chapter 1
Chapter 2
Chapter 3
Planning
Initial Requirement
Design
Development
Prototyping
Testing
Maintenance

APPENDIX B. ACTUAL THESIS EXPENSES

Budgetary Estimate

Quantity	Item	Price	Amount
2	RFID reader/writer	₱ 150	₱ 300
2	Raspberry-Pi 4 Model B Microcontroller	₱ 8,000	₱ 16,000
2	8GB Micro SD Card	₱ 500	₱ 1000
2	Mini Thermal Printer	₱ 1,212	₱ 2,424
2	GPS module	₱ 700	₱ 1,400
2	Wi-Fi module	₱ 110	₱ 220
2	On/Off switch	₱ 100	₱ 200
2	8-inch touchscreen LCD display	₱ 1,965	₱ 3,930
2	Micro HDMI to HDMI cable	₱ 250	₱ 500
2	5V 3A Raspberry Pi Power Supply	₱ 350	₱ 700
2	Buzzer	₱ 51	₱ 102
8	Light Emitting Diode (LED)	₱ 3	₱ 24
70	Male-to-Female Jumper Wires	₱ 7	₱ 490
1	Soldering Iron	₱ 250	₱ 250
2	Soldering Lead	₱ 59	₱ 118
5	13.56 MHz RFID card	₱ 78	₱ 390
2	57mm Thermal Paper	₱ 90	₱ 180
1	GPS antenna	₱ 270	₱ 270
1	20000 mAh power bank	₱ 900	₱ 900
1	Steel joint	₱ 357	₱ 357
2	Acrylic case	₱ 252	₱ 504
500	Documentation (Printing)	₱ 7	₱ 3,500
		TOTAL	₱ 33,539

THESIS EXPENSES

Quantity	Specifics	Approximate Cost	Actual Cost
1	RC522 RFID reader module 13.56Mhz	₱ 150	₱ 119
1	Raspberry-Pi 4 Model B 8Gb Ram	₱ 8,000	₱ 6,816
1	32GB SanDisk Ultra micro SD Card Class 10	₱ 500	₱ 250
1	Mini Thermal Printer with 57mm Thermal Paper	₱ 1,212	₱ 1,045
1	GPS module Ublox (NEO-M8N) with Antenna	₱ 700	₱ 599
1	On/Off switch	₱ 50	₱ 50
1	1024x600 touchscreen LCD display (7 inch)	₱ 1,965	₱ 2,900
1	1.5m Micro HDMI to HDMI cable	₱ 250	₱ 100
1	Okdo 5V 3A Raspberry Pi Power Supply PSU USB Type C with US Plug 1.5m	₱ 350	₱ 480
1	Grove-Buzzer | 107020000	₱ 51	₱ 50
2	Light Emitting Diode (LED)	₱ 6	₱ 10
80	Female-to-Female Jumper Wires & Male-to-Male Jumper Wires	₱ 580	₱ 130
10	13.56 MHz RFID/NFC card	₱ 78	₱ 13.50
1	20000 mAh power bank	₱ 900	₱ 304.20
	Steel joint	₱ 357	₱ 914
	Acrylic Casing	₱ 2,000	₱ 1,416
	Documentation (Printing)	₱ 3,000	₱ 1,500
	Others	₱ 2,000	₱ 3,207
	TOTAL	**₱ 22,155**	**₱ 20,129.20**

Prepared by:

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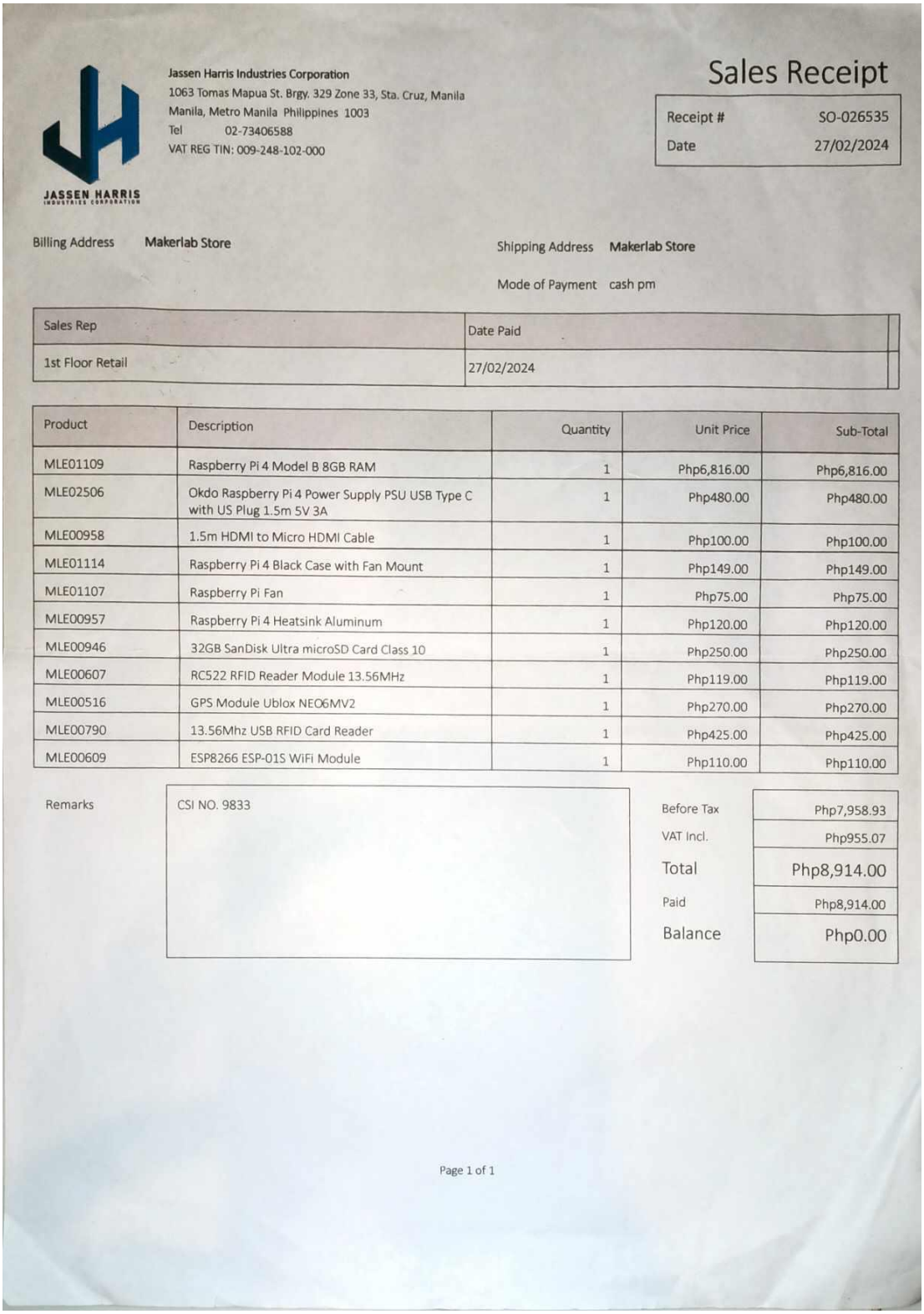
Noted by:

Fe G. Rosales Jennifer Y. Cabillo

Epifania D.G. Escuton Ryan G. San Miguel

Approved by:

Engr. Santiago M. Liwanag, MIT Engr. Regina R. Mape, MIT



Jassen Harris Industries Corporation
1063 Tomas Mapua St. Brgy. 329 Zone 33, Sta. Cruz, Manila
Manila, Metro Manila Philippines 1003
Tel 02-73406588
VAT REG TIN: 009-248-102-000

Sales Receipt

Receipt #	SO-026535
Date	27/02/2024

Billing Address **Makerlab Store**

Shipping Address **Makerlab Store**

Mode of Payment cash pm

Sales Rep	Date Paid
1st Floor Retail	27/02/2024

Product	Description	Quantity	Unit Price	Sub-Total
MLE01109	Raspberry Pi 4 Model B 8GB RAM	1	Php6,816.00	Php6,816.00
MLE02506	Okdo Raspberry Pi 4 Power Supply PSU USB Type C with US Plug 1.5m 5V 3A	1	Php480.00	Php480.00
MLE00958	1.5m HDMI to Micro HDMI Cable	1	Php100.00	Php100.00
MLE01114	Raspberry Pi 4 Black Case with Fan Mount	1	Php149.00	Php149.00
MLE01107	Raspberry Pi Fan	1	Php75.00	Php75.00
MLE00957	Raspberry Pi 4 Heatsink Aluminum	1	Php120.00	Php120.00
MLE00946	32GB SanDisk Ultra microSD Card Class 10	1	Php250.00	Php250.00
MLE00607	RC522 RFID Reader Module 13.56MHz	1	Php119.00	Php119.00
MLE00516	GPS Module Ublox NEO6MV2	1	Php270.00	Php270.00
MLE00790	13.56Mhz USB RFID Card Reader	1	Php425.00	Php425.00
MLE00609	ESP8266 ESP-01S WiFi Module	1	Php110.00	Php110.00

Remarks CSI NO. 9833

Before Tax	Php7,958.93
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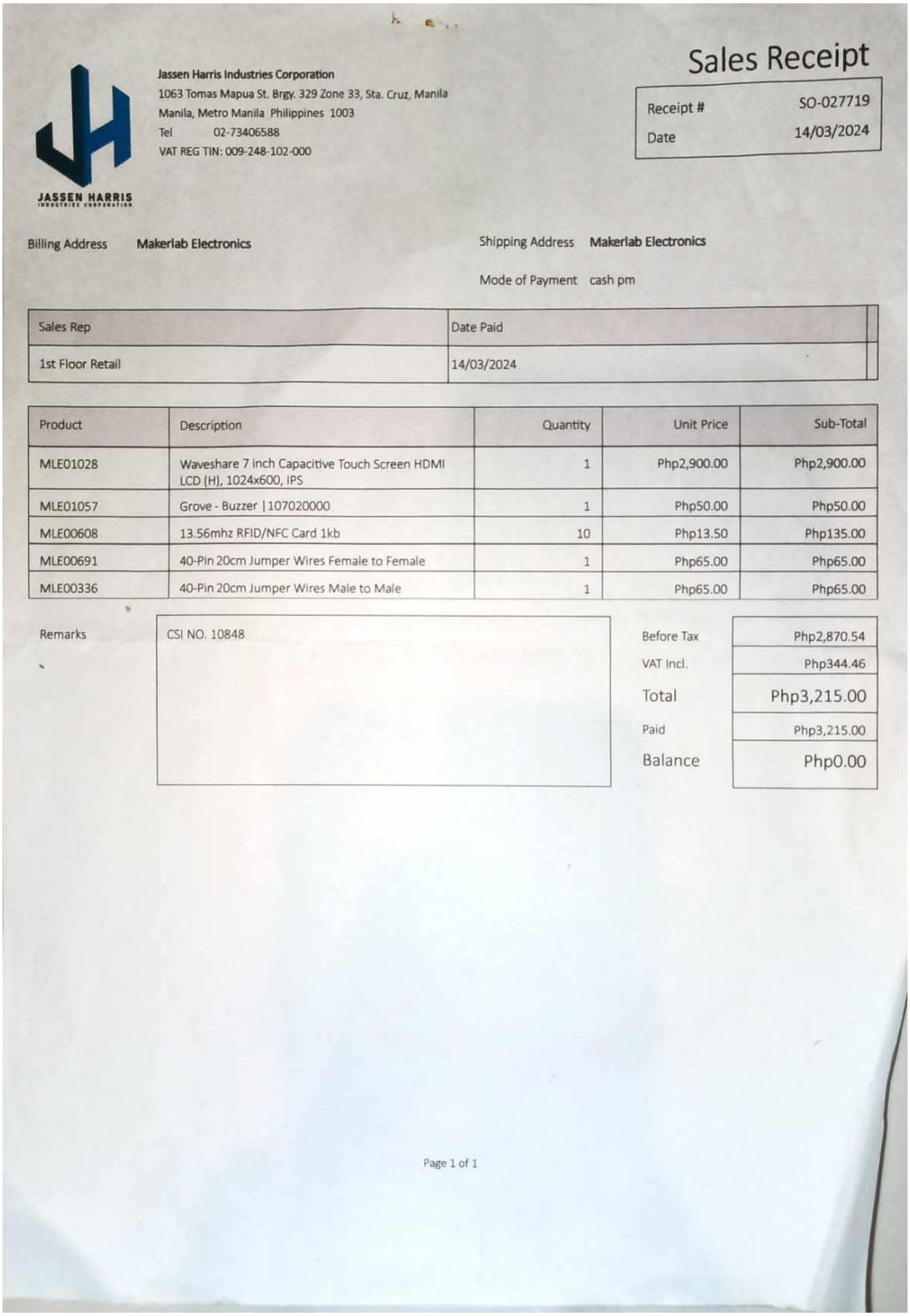
Balance	Php0.00

Page 1 of 1



Jassen Harris Industries Corporation
1063 Tomas Mapua St. Brgy. 329 Zone 33, Sta. Cruz, Manila
Manila, Metro Manila Philippines 1003
Tel 02-73406588
VAT REG TIN: 009-248-102-000

JASSEN HARRIS
INDUSTRIES CORPORATION

Sales Receipt

Receipt #	SO-027719
Date	14/03/2024

Billing Address **Makerlab Electronics**

Shipping Address **Makerlab Electronics**

Mode of Payment cash pm

Sales Rep	Date Paid
1st Floor Retail	14/03/2024

Product	Description	Quantity	Unit Price	Sub-Total
MLE01028	Waveshare 7 inch Capacitive Touch Screen HDMI LCD (H), 1024x600, IPS	1	Php2,900.00	Php2,900.00
MLE01057	Grove - Buzzer | 107020000	1	Php50.00	Php50.00
MLE00608	13.56mhz RFID/NFC Card 1kb	10	Php13.50	Php135.00
MLE00691	40-Pin 20cm Jumper Wires Female to Female	1	Php65.00	Php65.00
MLE00336	40-Pin 20cm Jumper Wires Male to Male	1	Php65.00	Php65.00

Remarks CSI NO. 10848

Before Tax	Php2,870.54
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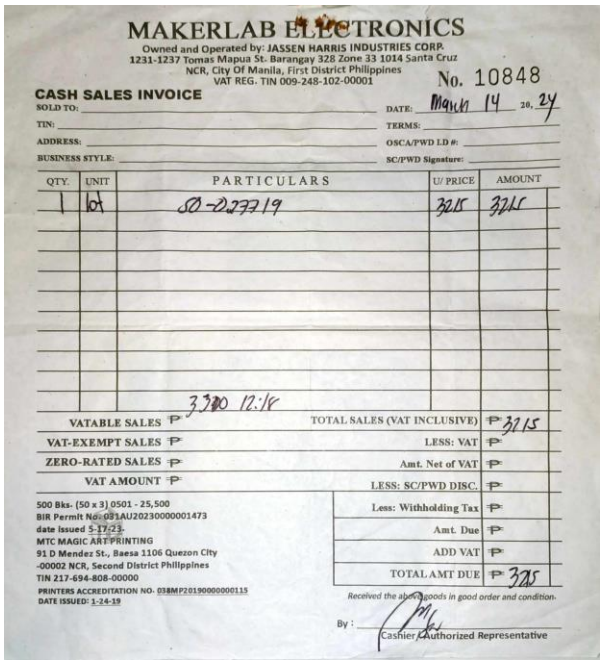
Page 1 of 1



MAKERLAB ELECTRONICS

Owned and Operated by: JASSEN HARRIS INDUSTRIES CORP.
1231-1237 Tomas Mapua St. Barangay 328 Zone 33 1014 Santa Cruz
NCR, City Of Manila, First District Philippines
VAT REG. TIN 009-248-102-00001

No. 10848

CASH SALES INVOICE

SOLD TO: _____ DATE: March 14 20, 24
TIN: _____ TERMS: _____
ADDRESS: _____ OSCA/PWD I.D #: _____
BUSINESS STYLE: _____ SC/PWD Signature: _____

QTY.	UNIT	PARTICULARS	U/PRICE	AMOUNT
1	lot	SO-027719	3215	3215

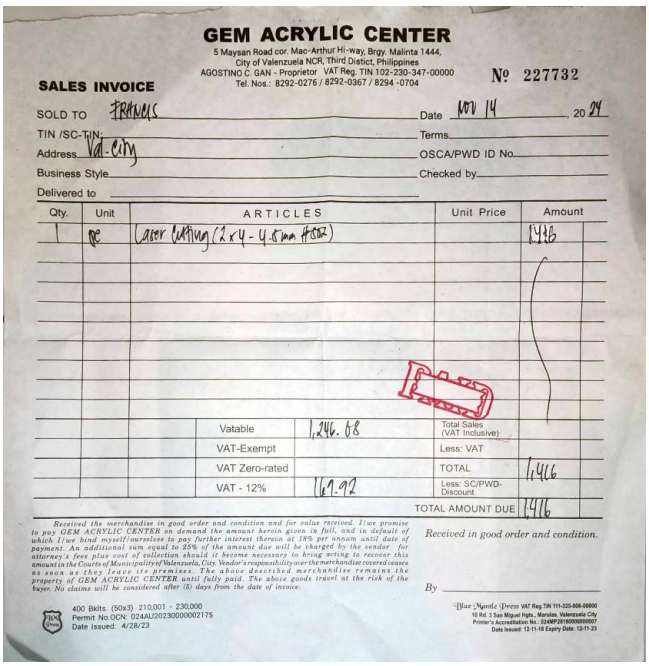
3280 12:18

VATABLE SALES ₱ — TOTAL SALES (VAT INCLUSIVE) ₱ 3215
VAT-EXEMPT SALES ₱ — LESS: VAT ₱
ZERO-RATED SALES ₱ — Amt. Net of VAT ₱
VAT AMOUNT ₱ — LESS: SC/PWD DISC. ₱
Less: Withholding Tax ₱
Amt. Due ₱
ADD VAT ₱
TOTAL AMT DUE ₱ 3215

500 Bks- (50 x 3) 0501 - 25,500
BIR Permit No. 033AU20230000001473
date issued 5-17-23-
MTC MAGIC ART PRINTING
91 D Mendez St., Baesa 1106 Quezon City
-00002 NCR, Second District Philippines
TIN 217-696-808-00000
PRINTERS ACCREDITATION NO. 038MP20190000000115
DATE ISSUED: 1-24-19

Received the above goods in good order and condition.

By: _____
Cashier / Authorized Representative



GEM ACRYLIC CENTER

5 Maysan Road cor. Mac-Arthur Hi-way, Brgy. Malinta 1444,
City of Valenzuela NCR, Third Distict, Philippines
AGOSTINO C. GAN - Proprietor VAT Reg. TIN 102-230-347-00000
Tel. Nos.: 8292-0276 / 8292-0367 / 8294 -0704

№ 227732

SALES INVOICE

SOLD TO FRANCIS — Date Nov 14 20 24
TIN /SC-TIN: — Terms: _____
Address Val-City — OSCA/PWD ID No. _____
Business Style _____ — Checked by _____
Delivered to _____

Qty.	Unit	ARTICLES	Unit Price	Amount
1	pc	Laser Cutting (2x4 - 4.5mm Acrylic)		1446

Vatable	1,246.68	Total Sales (VAT Inclusive)	
VAT-Exempt		Less: VAT	
VAT Zero-rated		TOTAL	1446
VAT - 12%	149.92	Less: SC/PWD-Discount	
		TOTAL AMOUNT DUE	1446

Received the merchandise in good order and condition and for value received. I/we promise to pay GEM ACRYLIC CENTER on demand the amount herein given in full, and in default of which I/we bind myself/ourselves to pay further interest thereon at 18% per annum until date of payment. An additional sum equal to 25% of the amount due will be charged by the sender for attorney's fees plus cost of collection should it become necessary to bring acting to recover this amount in the Courts of Municipality of Valenzuela, City. Vendor's responsibility over the merchandise covered ceases as soon as they leave its premises. The above described merchandise remains the property of GEM ACRYLIC CENTER until fully paid. The above goods travel at the risk of the buyer. No claims will be considered after (5) days from the date of invoice.

Received in good order and condition.

By _____

400 Bkts. (50x3) 210,001 - 230,000
Permit No.OCN 024AU20230000002175
Date Issued: 4/28/23

31 OCT — 2 NOV
FIRST MILE (Pickup) — DELIVERY
LEX PH — LEX PH
STA
Customer: Marianne Escuton
[HOME] Bulacan | Plaridel | Bulihan
Address: 0704-A
915716482443981
H-GUI-C8
Sold by: hensaxph
Shipped thru Lazada
Seller Address: #438 General Luis St., Barangay 166, Caybiga Caloocan City, Metro Manila-Caloocan, Caloocan City, Barangay 166
COD
PHP 304.20
Route Code H-GUI-C8
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Origin: MP
Profile: Small
QTY
1

APPENDIX C. LIST OF FLOWCHARTS

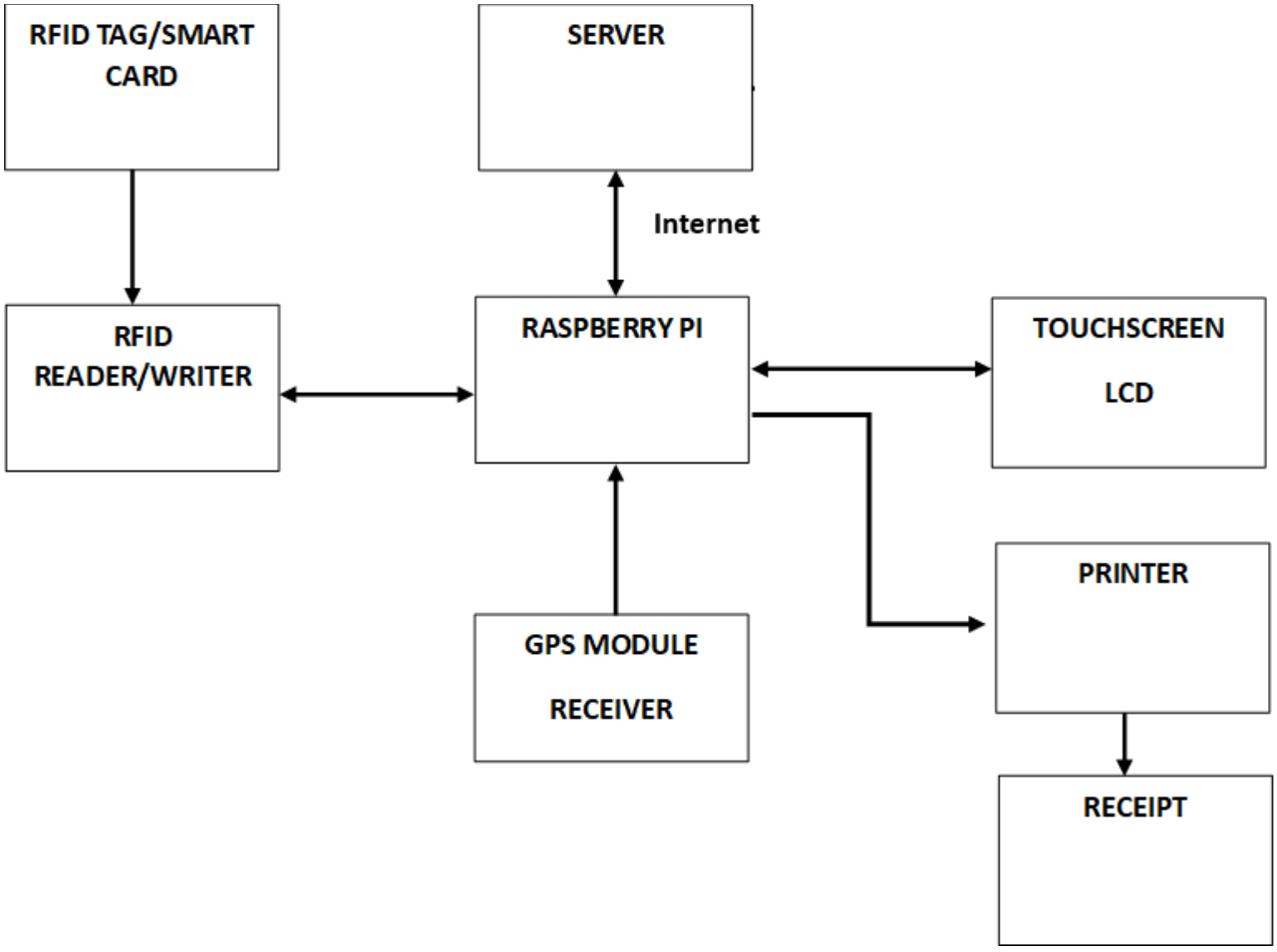


Figure 1: Block Diagram

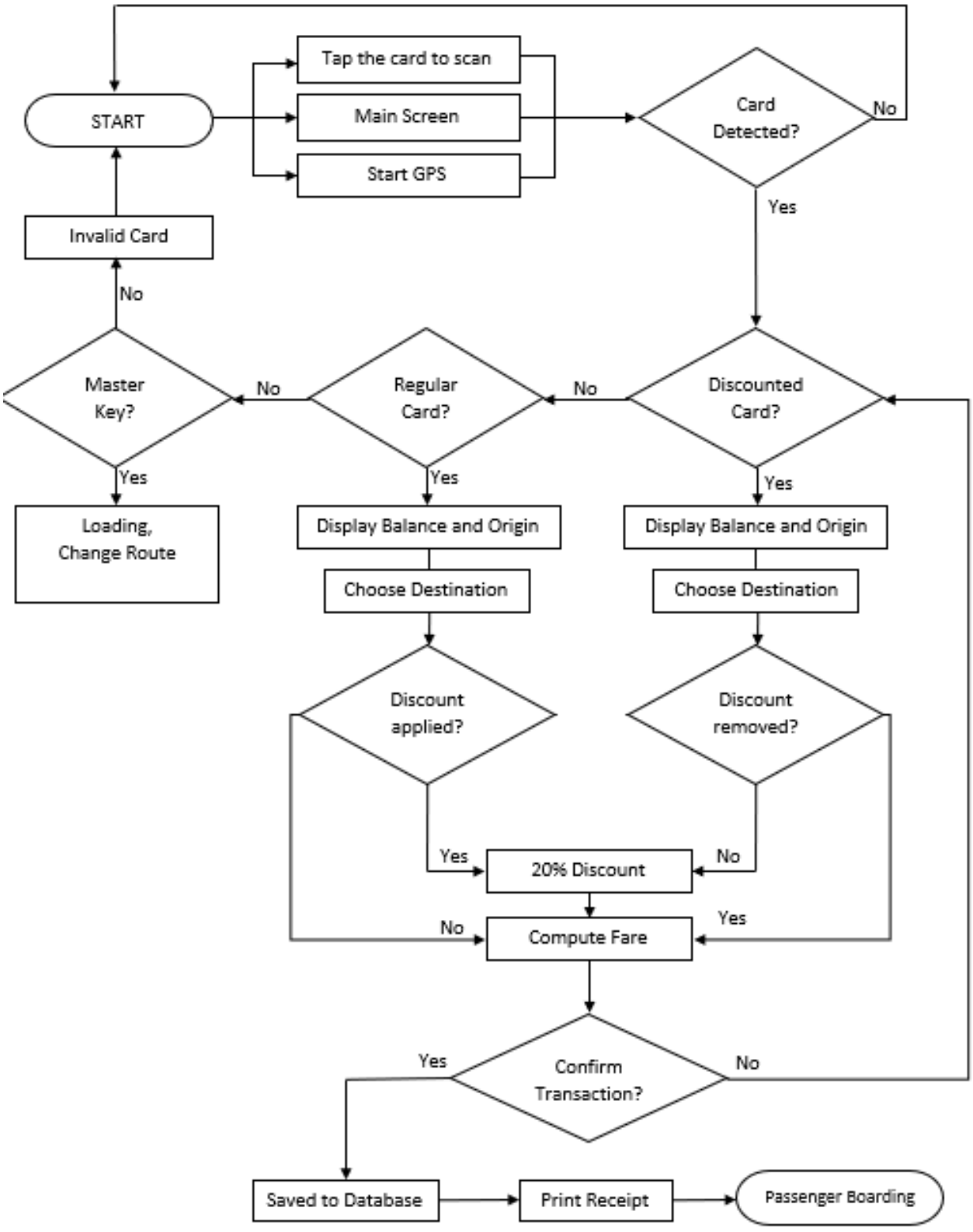


Figure 2: Tap-in

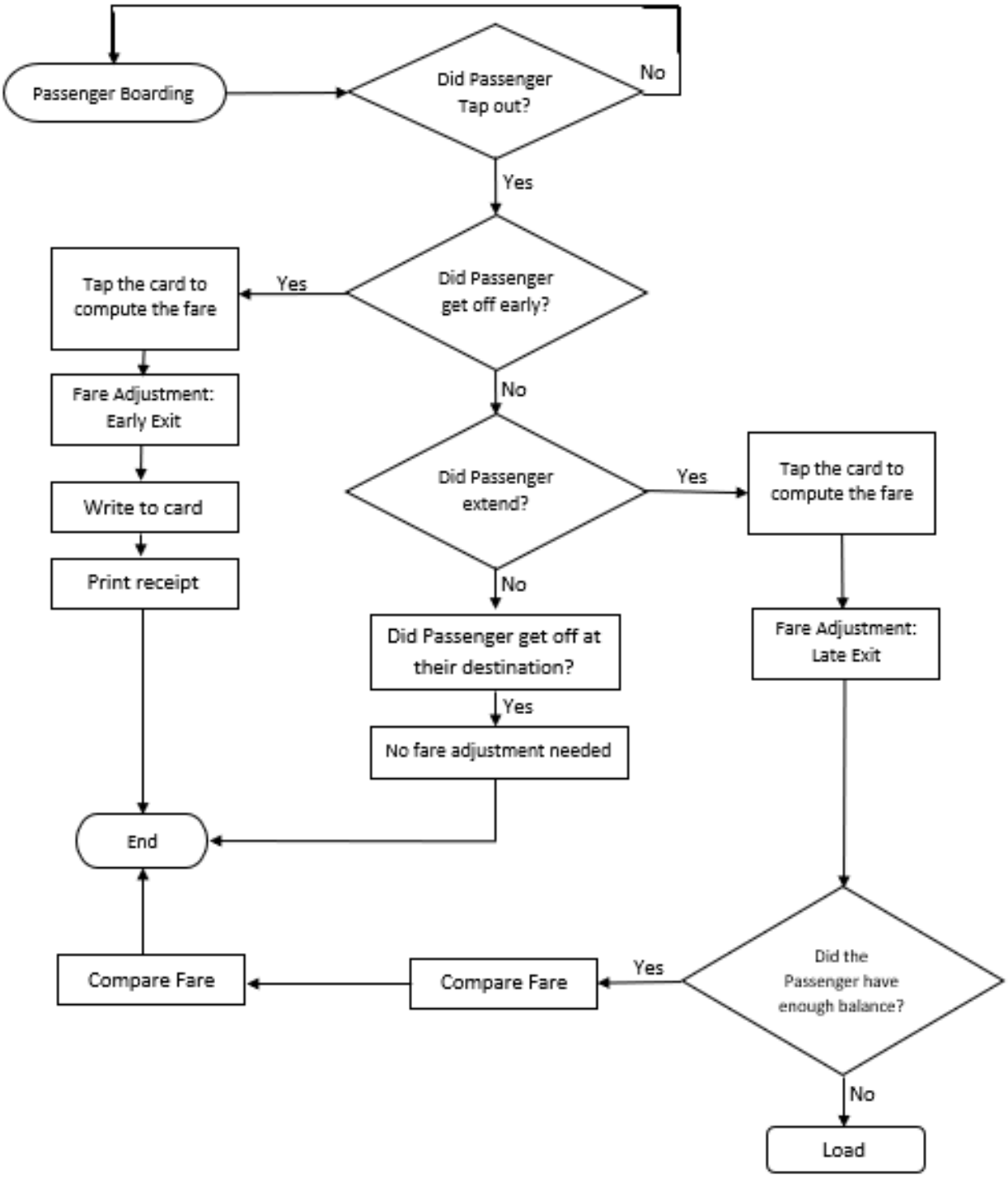


Figure 3: Tap-out

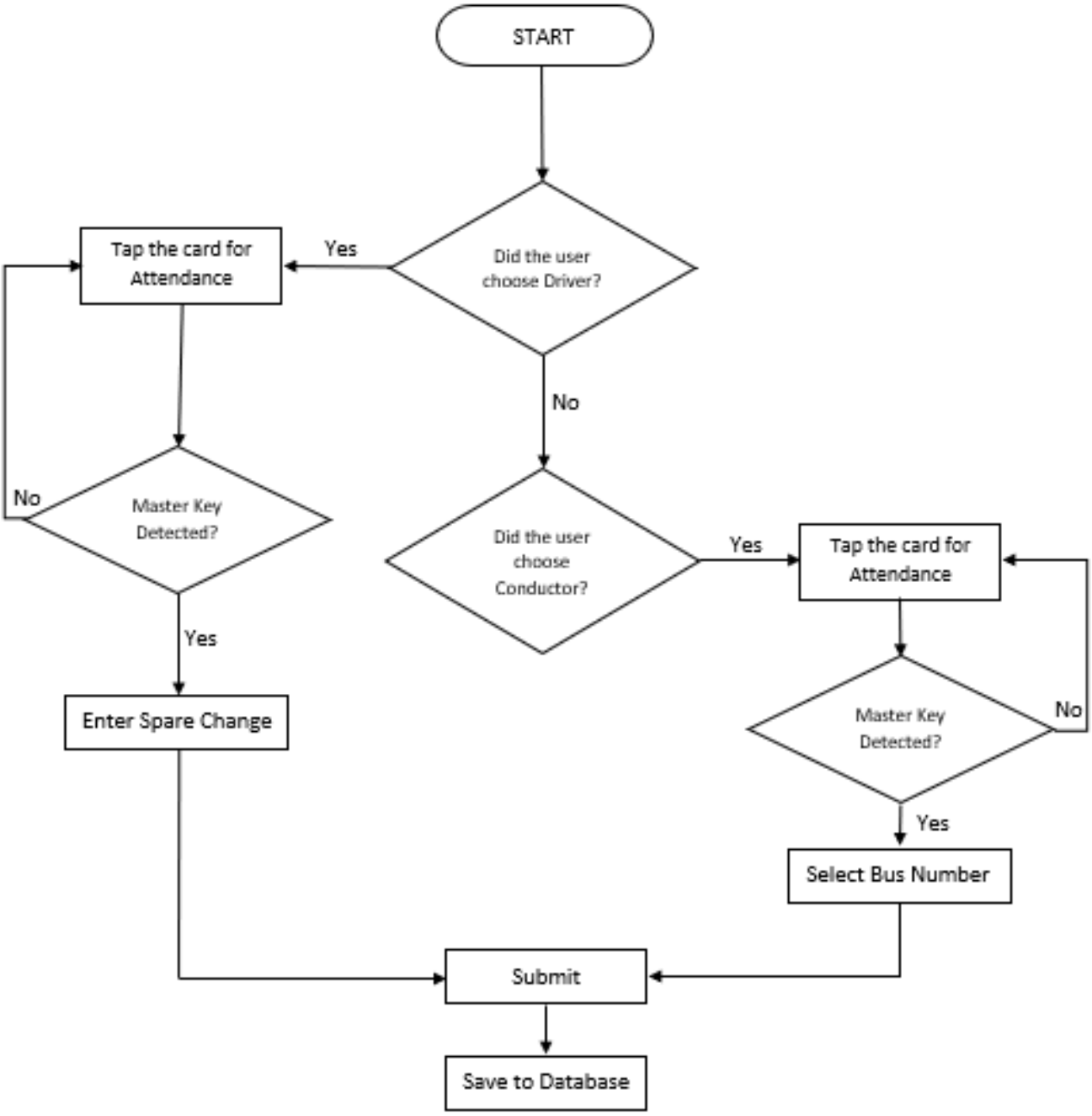


Figure 4: Attendance

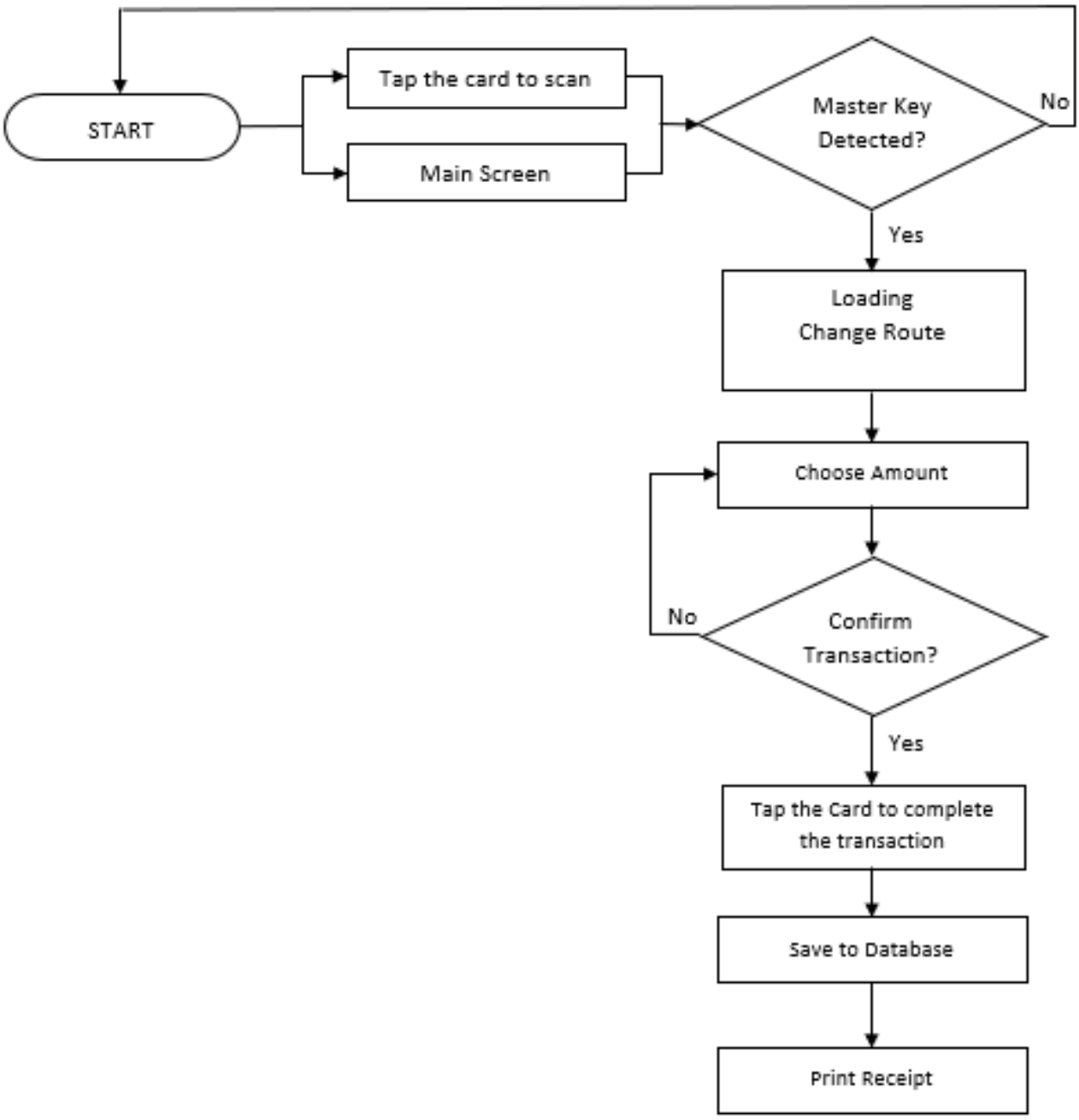


Figure 5: Loading

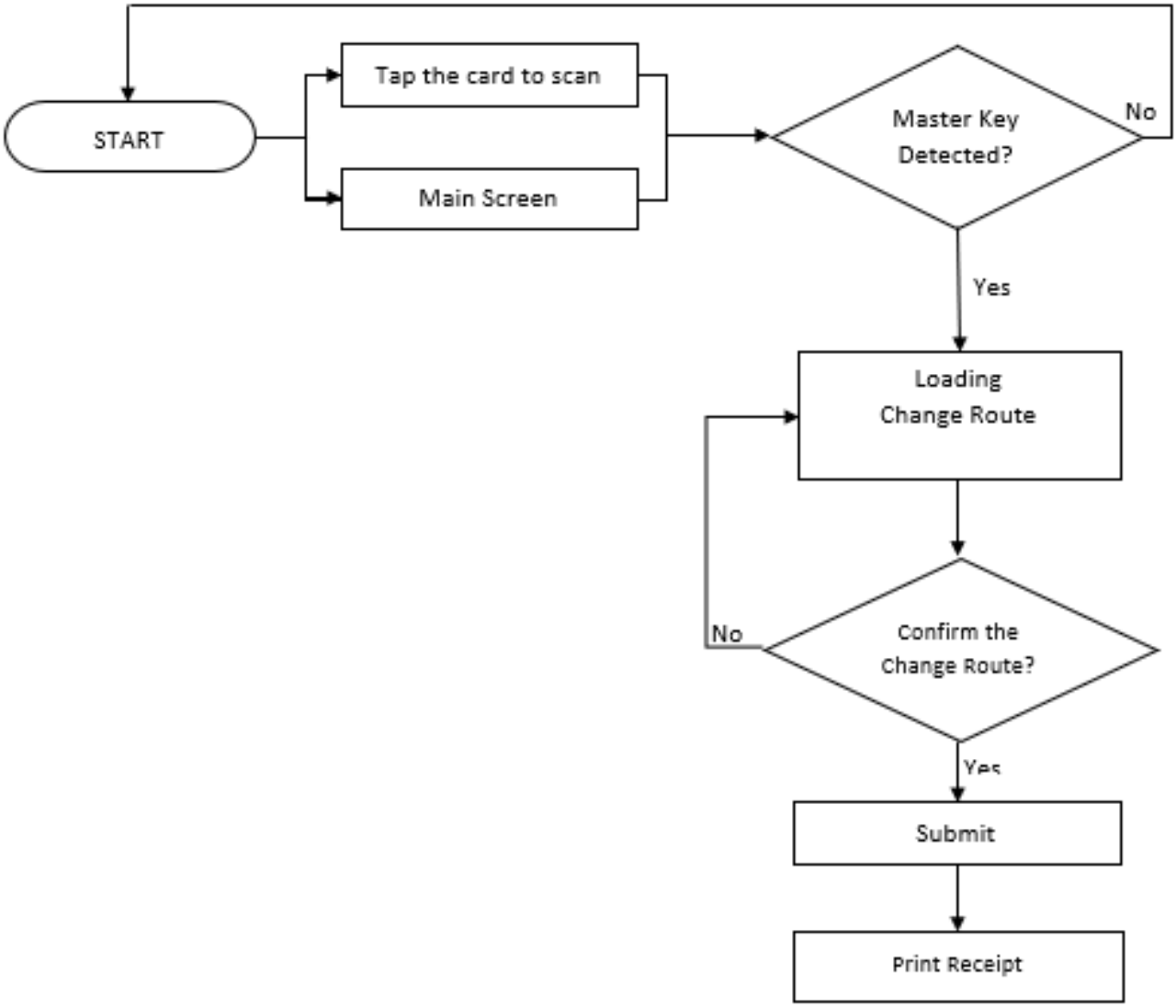


Figure 6: Change Route

APPENDIX D. LIST OF FIGURES

Components

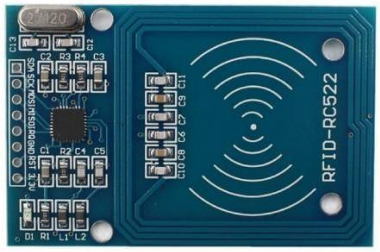


Figure 7 – RFID module

Figure 8 – Raspberry Pi 4 model B

Figure 9 – Mini Thermal Printer

Figure 10 – GPS module

Figure 11 – 7 inch Touchscreen display

Figure 12 – On/Off switch

Figure 13 - 5V 3A Raspberry Pi Power Supply

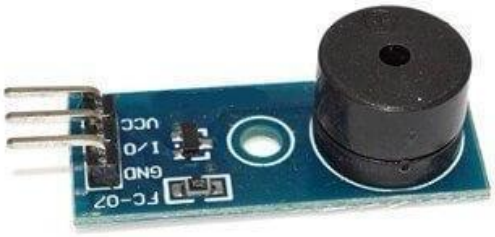


Figure 14 - Buzzer

Figure 15 – RFID card

Figure 16 - LED

Testing of Components

Figure 17 - Touch Screen LCD Testing

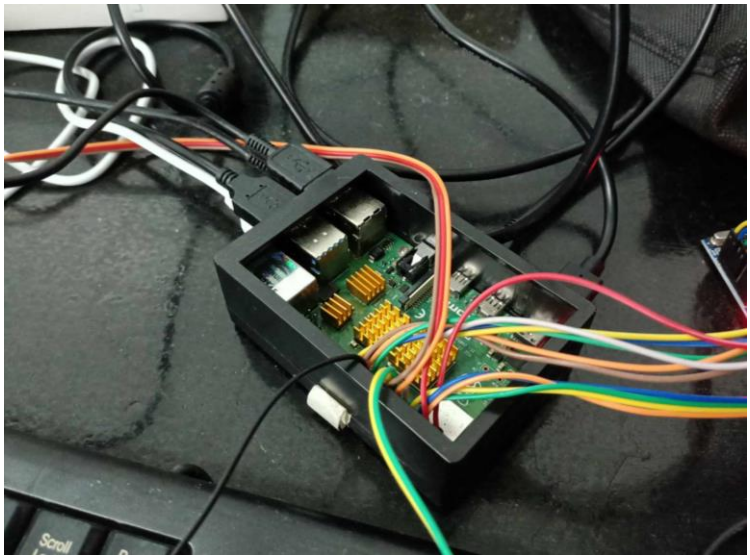


Figure 18 – Raspberry Pi Testing

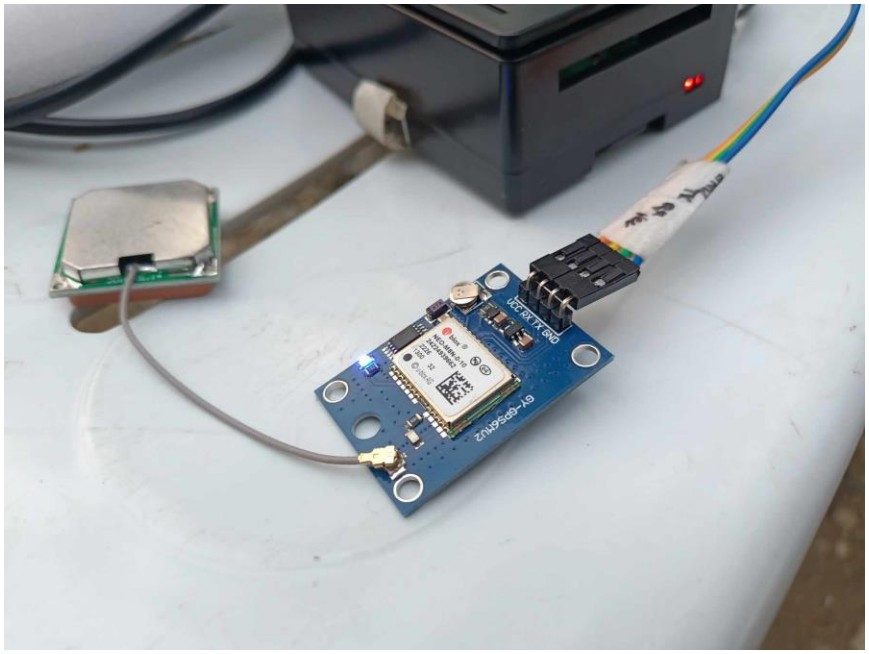


Figure 19 – GPS Testing

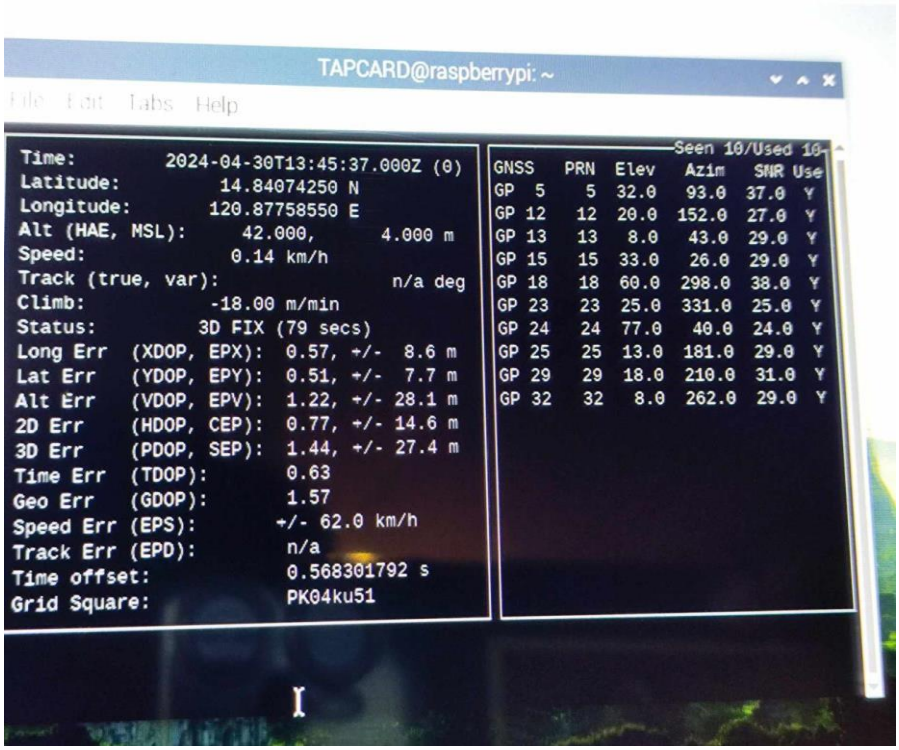

TAPCARD@raspberrypi: ~
File Edit Tabs Help
Time: 2024-04-30T13:45:37.000Z (0)
Latitude: 14.84074250 N
Longitude: 120.87758550 E
Alt (HAE, MSL): 42.000, 4.000 m
Speed: 0.14 km/h
Track (true, var): n/a deg
Climb: -18.00 m/min
Status: 3D FIX (79 secs)
Long Err (XDOP, EPX): 0.57, +/- 8.6 m
Lat Err (YDOP, EPY): 0.51, +/- 7.7 m
Alt Err (VDOP, EPV): 1.22, +/- 28.1 m
2D Err (HDOP, CEP): 0.77, +/- 14.6 m
3D Err (PDOP, SEP): 1.44, +/- 27.4 m
Time Err (TDOP): 0.63
Geo Err (GDOP): 1.57
Speed Err (EPS): +/- 62.0 km/h
Track Err (EPD): n/a
Time offset: 0.568301792 s
Grid Square: PK04ku51
Seen 10/Used 10
GNSS PRN Elev Azim SNR Use
GP 5 5 32.0 93.0 37.0 Y
GP 12 12 20.0 152.0 27.0 Y
GP 13 13 8.0 43.0 29.0 Y
GP 15 15 33.0 26.0 29.0 Y
GP 18 18 60.0 298.0 38.0 Y
GP 23 23 25.0 331.0 25.0 Y
GP 24 24 77.0 40.0 24.0 Y
GP 25 25 13.0 181.0 29.0 Y
GP 29 29 18.0 210.0 31.0 Y
GP 32 32 8.0 262.0 29.0 Y

Figure 20 – GPS Testing Result

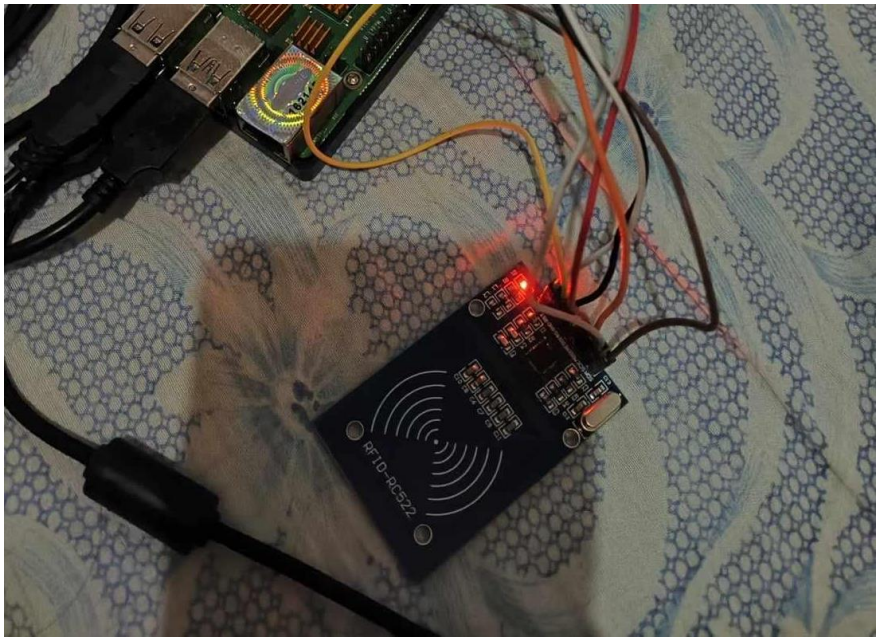


Figure 21 – RFID Reader/Writer Testing

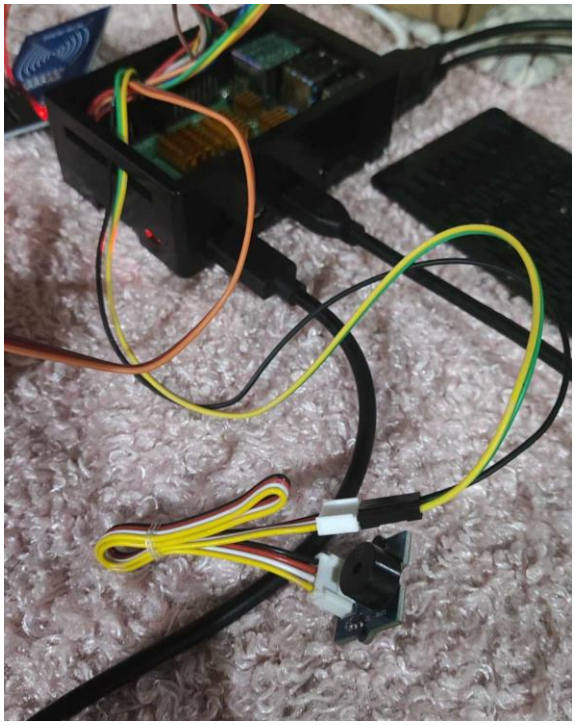


Figure 22 – Buzzer Testing

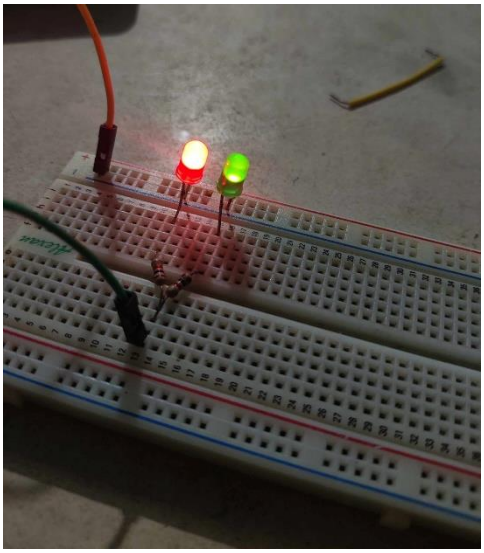


Figure 23 – LED Testing

Figure 24 – Mini Thermal Printer Testing

APPENDIX E. THREE-DIMENSIONAL STRUCTURE

Figure 25 – Front and Back View

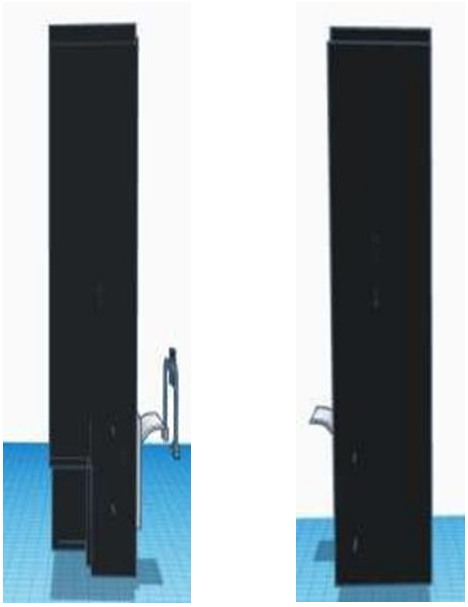


Figure 26 – Side View

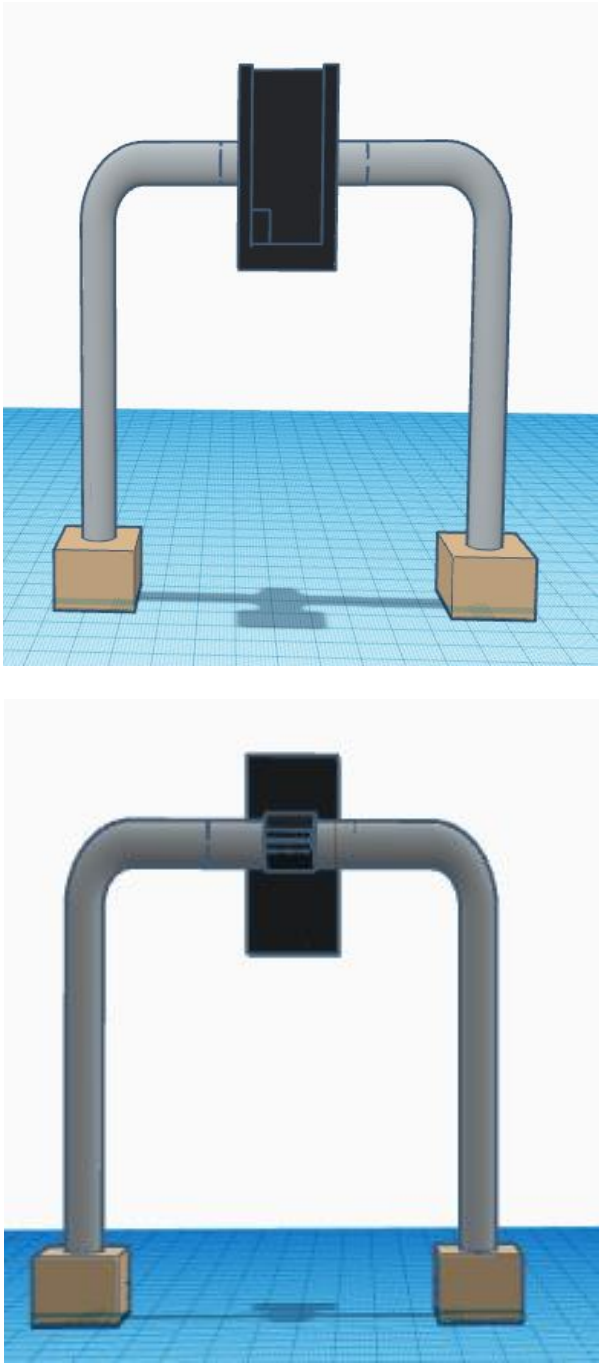
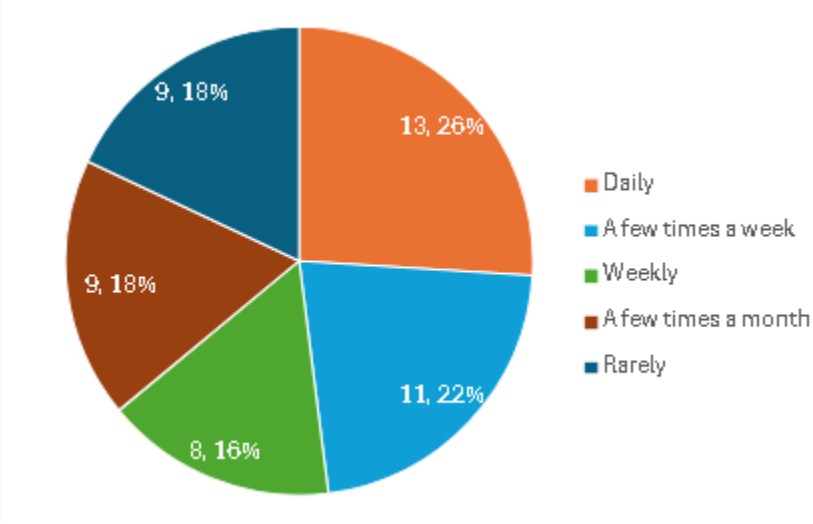


Figure 27 – Device Case

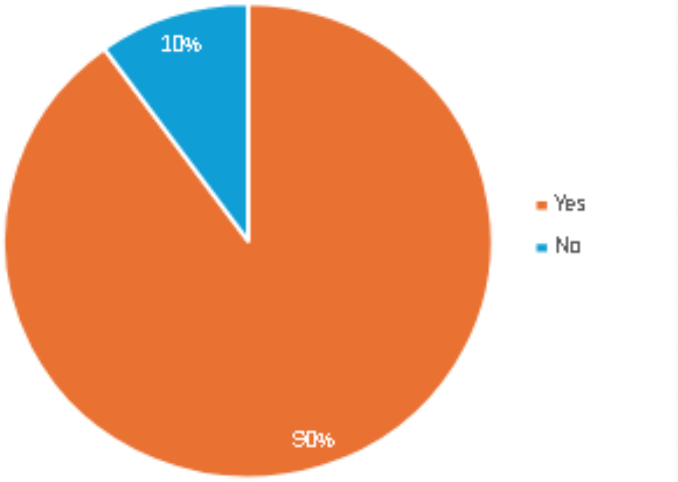
APPENDIX F. TRANSCRIPTION OF SURVEY

Survey Questionnaire Overall Chart
(Proponents surveyed 50 persons)

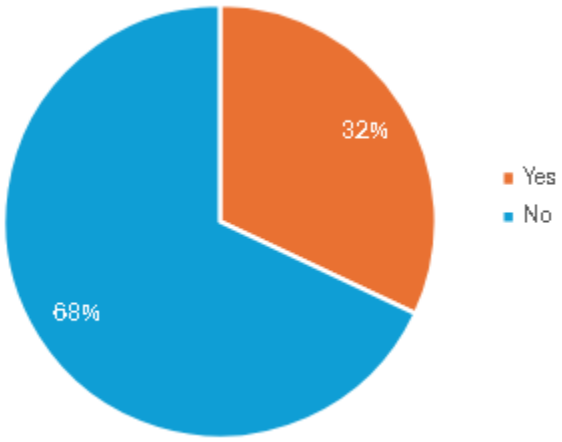
- How often do you use modern PUVs?



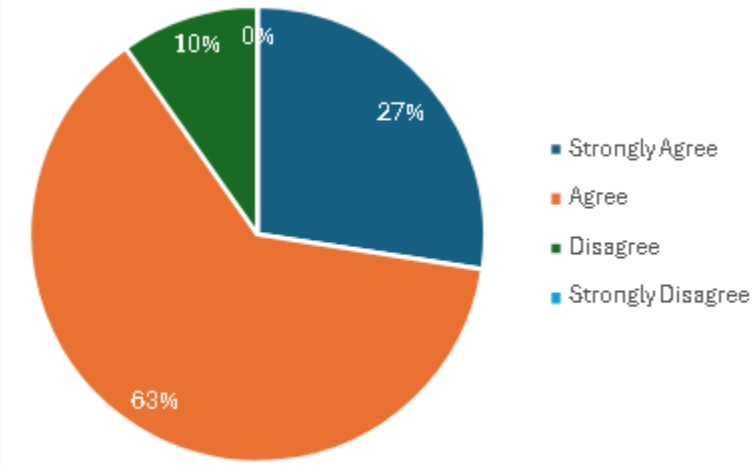
- Are you familiar with cashless payment systems like cards?



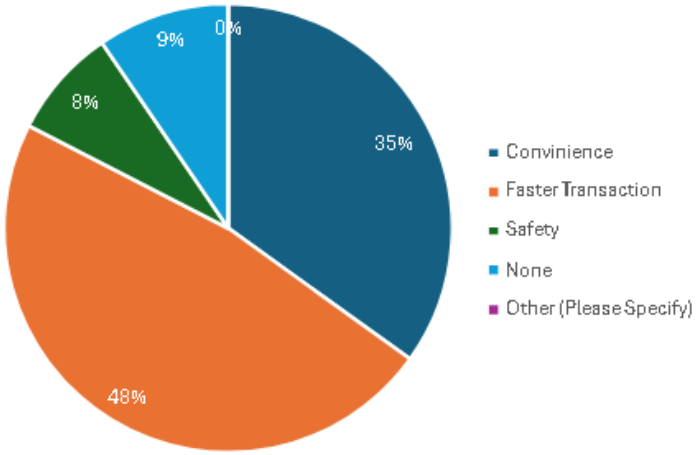
- Do you currently use any cashless payment system for transportation?



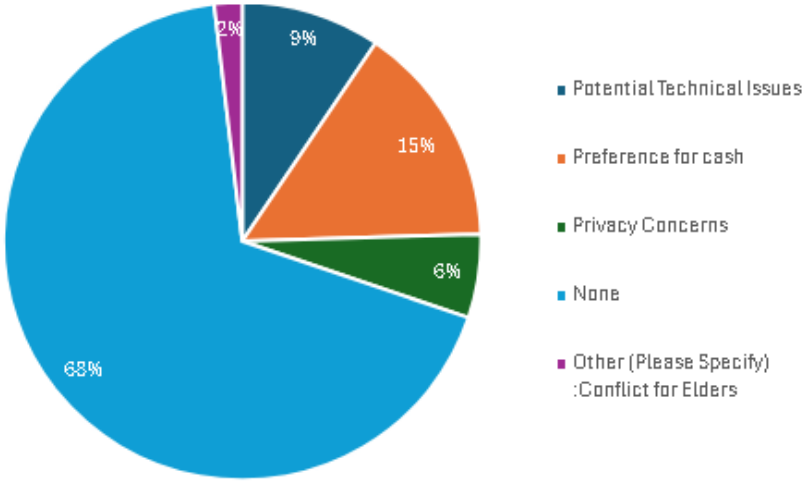
- Do you agree with implementing a cashless payment system in modern PUVs?



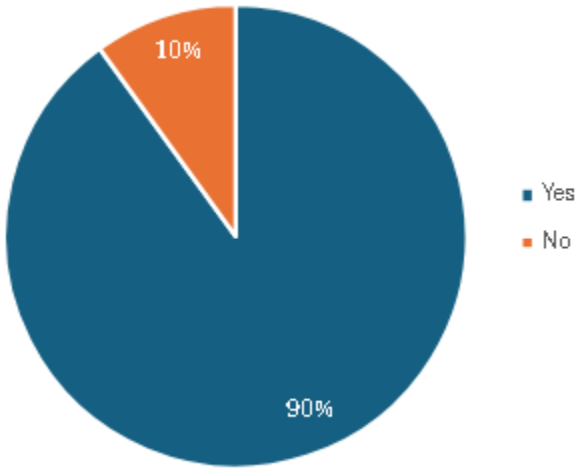
- If you agree with a cashless payment system, what is the main reason for your support?



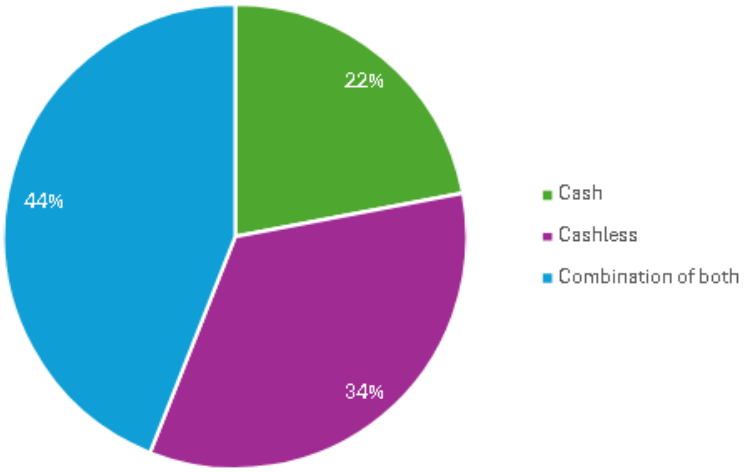
- If you disagree, what is the main reason for your concern?



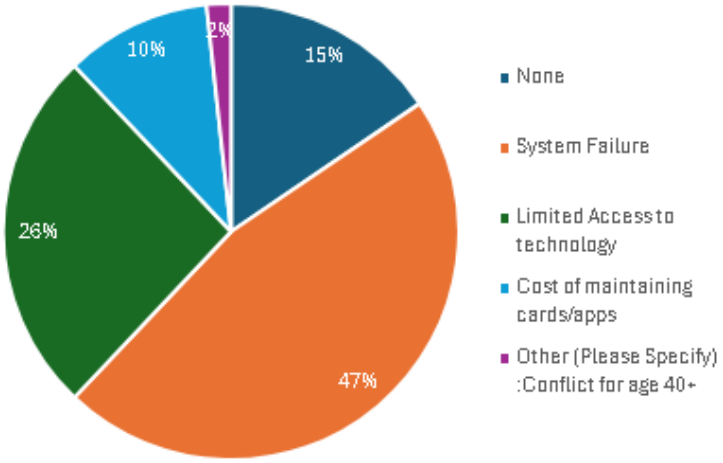
- Would you be willing to use a reloadable card to pay for your PUV fare?



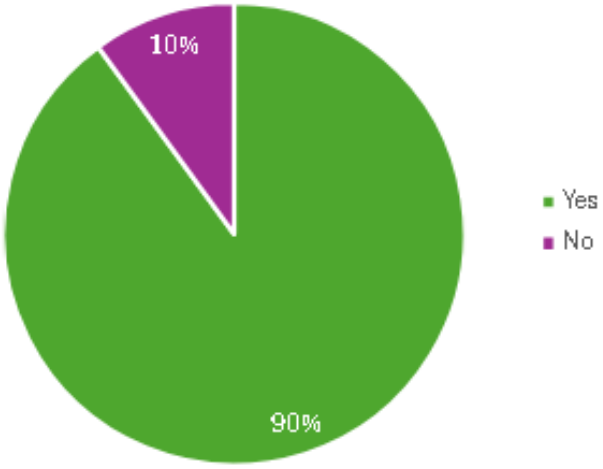
- What is your preferred method of payment for PUVs?



- What are your concerns (if any) about transitioning to a fully cashless payment system?



- Do you think the implementation of a cashless payment system will improve your overall commuting experience?



APPENDIX G. TRANSCRIPTION OF INTERVIEW

Interview (*See Appendix C, Figure 18, 19, 20: Photos of the Interview*) Chairman: Marionito T. Cabasal

Ano-ano ang mga stations sa existing device?

(Hagonoy - Meycauyan via Calumpit (Northbound))

-STAROIL/PUREGOLD BRGY. BANGA MEYCAUAYAN

-CROSSING BGRY.MALHAKAN

-MCJ ALUMINUM GLASS TRADING/PANDAYAN

-SM MARILAO

-MARILAO PUBLIC MARKET

-TOYOTA MARILAO, ABANGAN SUR MARILAO

-HONDA LOLOMBOY

-PETRON BRGY.BONLO, BOCAUE BDO -BINANG FIRST, BOCAUE

-BOCAUE PUBLIC MARKET

-PTT GAS STATION, BRGY.WAWA BOCAUE

-INTER CITY GATE 1, BALAGTAS

-BALAGTAS MUNICIPAL HALL

-STI COLLEGES BRGY.BUROL 1ST BALAGTAS

-TUKTUKAN GAS STATION GUIGUINTO

-PUREGOLD GUIGUINTO

-WALTERMART GUIGUINTO

-TESDA GUIGUINTO

-TABANG/TULAY GUIGUINTO

-TIKAY ELEMENTARY SCHOOL MALOLOS

-CROSSING BRGY.SAN PABLO MALOLOS

-PARADISE HOTEL BRGY.DAKILA MALOLOS

-STI COLLEGES MALOLOS

-SUNLIFE MALOLOS CROSSING BRGY.GINHAWA

-BULACAN STATE UNIVERSITY

-BUILDERS WAREHOUSE BRGY.ALINO

-CENTRAL ESCOLAR CEU SCHOOL MALOLOS

-MBB ROYAL HARDWARE BRGY.LONGOS

-WILCON DEPOT BRGY.PIO CALUMPIT

-BRGY.PIO CRUZCOSA CALUMPIT

-PETRON GAS STATION BRGY.BAGBAG

-LABANGAN BRIDGE CALUMPIT

-JOLLIBEE CALUMPIT

-CROSSING CALUMPIT/BRGY.CALIZON

-BOUNDARY OF CALIZON BULUSAN

-CROSSING BRGY.BULUSAN

-STA.LUCIA ELEMENTARY SCHOOL

-BOUNDARY OF SAN JOSESTA.LUCIA

-SAN JOSE ELEMENTARY SCHOOL

-RISING ZONE SAN JOSE

-SAN JUAN DAYCARE SCHOOL HAGONOY -BRGY.SAN JUAN/BRIDGE

-MRGB HARDWARE BRGY.SAN MIGUEL -PUROK II BRGY.SAN MIGUEL

-GAS AND SAVE GASOLINE STATION SAN AGUSTIN

-STO.NIÑO CHAPEL

-PUREGOLD/MERCURY HAGONOY

(Hagonoy - Meycauyan via Calumpit (Southbound))

- PUREGOLD/MERCURY HAGONOY

-STO.NIÑO CHAPEL

-GAS AND SAVE GASOLINE STATION SAN AGUSTIN

-PUROK II BRGY. SAN MIGUEL

-MRGB HARDWARE BRGY.SAN MIGUEL

-BRGY.SAN JUAN/BRIDGE

-SAN JUAN DAYCARE SCHOOL HAGONOY

-RISING ZONE SAN JOSE

-SAN JOSE ELEMENTARY SCHOOL

-BOUNDARY OF SAN JOSESTA.LUCIA

-STA.LUCIA ELEMENTARY SCHOOL

-CROSSING BRGY.BULUSAN

-BOUNDARY OF CALIZON-BULUSAN

-CROSSING CALUMPIT/BRGY.CALIZON

-JOLLIBEE CALUMPIT

-LABANGAN BRIDGE CALUMPIT PETRON

-GAS STATION BRGY.BAGBAG

-BRGY.PIO CRUZCOSA CALUMPIT

-WILCON DEPOT BRGY.PIO CALUMPIT

-MBB ROYAL HARDWARE BRGY.LONGOS

-CENTRAL ESCOLAR CEU SCHOOL MALOLOS BUILDERS WAREHOUSE BRGY.ALINO

-BULACAN STATE UNIVERSITY

-SUNLIFE MALOLOS CROSSING BRGY.GINHAWA

-STI COLLEGES MALOLOS

-PARADISE HOTEL BRGY.DAKILA MALOLOS

-CROSSING BRGY.SAN PABLO MALOLOS TIKAY

-ELEMENTARY SCHOOL MALOLOS TABANG/TULAY GUIGUINTO

-TESDA GUIGUINTO

-WALTERMART GUIGUINTO

-PUREGOLD GUIGUINTO

-TUKTUKAN GAS STATION GUIGUINTO

-STI COLLEGES BRGY.BOROL 1ST BALAGTAS

-BALAGTAS MUNICIPAL HALL

-INTER CITY GATE 1, BALAGTAS

-PTT GAS STATION, BRGY.WAWA BOCAUE

-BOCAUE PUBLIC MARKET

-BDO BINANG FIRST, BOCAUE

-PETRON BRGY.BONLO, BOCAUE

-HONDA LOLOMBOY

-TOYOTA MARILAO, ABANGAN SUR MARILAO

-MARILAO PUBLIC MARKET SM MARILAO

-MCJ ALUMINUM GLASS TRADING / PANDAYAN

-CROSSING BGRY.MALHAKAN

-STAROIL/PUREGOLD BRGY. BANGA MEYCAUAYAN

Paano namomonitor yung income ng bawat E-jeep?

- Namomonitor yung kinikita nila using gadget. May thermal something na ginagamit para mapasa yung data from gadget then irerecord yon. Daily namin ginagawa yon.

Paano nyo po naitatally yung data galing sa device, sa perang nireremit ng conductors?

- Kada end ng shift ng driver at conductor, doon sila nag reremit at nagtatally. Sa gadget nakikita yung total ng kinita for that day (by ticket), then itatally sa total cash (manual) na nacollect nila. Dapat magtugma yung pera sa data para maiwasan yung pagkashort, madalang lang naman yung may sobrang kita. Ang problema lang ay yung pagreremit ng pera dahil barya-barya. Matagal bilangin kaya doon kami nagtatagal.

May case po ba na hindi nagtatally yung nireremit sa data na narecord?

- Yes meron. Kulang yung niremit dahil minsan may mga conductors na nangungupit. Meron din na nabigyan na ng ticket yung pasahero pero di paren nagbayad at nakalimutan na singilin ng conductor. Pag ganon, ang ginagawa namin ay dededuct sa sahod ng driver at konduktor pagkulang yung nireremit nila (either mababawas sa sweldo or babayaran nila).
- Meron din case na nagbabayad nalang yung pasahero kahit walang ticket so di narerecord yon. (kaya nirerequire nila na magbigay ng ticket) Kaya nagtitiwala nalang kami na sasabihin nila yung totoo at ireremit nila kung sakali.

Owned po ba ng company yung jeep?

- Owned by company yung E-jeep.

Paano nyo po pinapasweldo yung mga drivers at conductors?

- Sa total ng kinita nila, doon ibabase yung sahod nila per day pero may daily rates sila. (nagkakaroon din sila ng incentives).

Paano po gumagana yung device?

- Nasa gadget na mismo yung destination at origin kada station, bali itatap lang yon then lalabas yung total ng babayaran mo base sa lugar na pupuntahan.
- Power by charger yung gadget, pwedeng icharge sa terminal or sa mismong jeep may charger (incase).

May mga pasahero po ba na nagbabayad using beep cards? Pano po ang pagbabayad using beep cards?

- Meron naman pero sobrang konti nila. Ang reason nila dahil baka daw mawala yung card at di sila makapagbayad at mas madali daw kung cash nalang pero kahit ganon ineencourage parin naman sila na bumili ng beep card. May times na pinapabenta namin yung mga cards sa conductors pagbumabyahe.
- Types of beep card, Blue regular, White may discount (binebenta sya ng company, meron din sa online) Gcash or any other online payment pangload.
- Same gadget or device parin yung ginagamit pag magbabayad thru beep card (may card scanner).
- Direct to the bank ng company yung bayad (anytime), using a card with no transaction fee.
- Using card, may case na minsan di pumapasok yung pera sa pinakadevice, pero nababawas sa balance ng card ng passenger (no records).

Capacity of modern jeep:

- Seating capacity: 26 people, standing 8 people.

The total number of jeeps in ChatCo Company.

- 34 total jeep

How much is the daily income of a Modern Jeep? (Approximate, min of? max of?)

- ₱150,000 minimum (profit in 34 jeep)
- ₱200,000 maximum

How much is the salary of a modern jeep's conductor and driver?

- Driver 200 pesos per trip (3 trips total of 600 per day)
- Conductor 150 pesos per trip (3 trips total of 450 per day)

Are their salaries the same?

- Magkaiba ang sweldo nila, mas mataas ang kay driver dahil sa magkaiba nilang work, like need ng lisensya at skills sa pagdadrive.

Basis for the incentives of conductors and drivers, if any?

- Nagbabase yung incentives nila pagnareach nila yung designated na amount na kailangan, example is pagnareach nila is yung 5000 magkakaroon ng plus 50 yung sahod nila, 5500 plus 100, 6000 plus 150, base sa profit na nakukuha nila. 50/50 din naman ang hatian ng driver at conductor.

Do the driver and conductor have access to any other government benefits, such as PhilHealth or SSS?

- Yes

Working hours of driver and conductor? 8 hours? 12 hours? Basis?

- 1 trip estimated is 2 hours, 4 hours ang balikan to Calumpit to Meycauayan vice versa, bali total of 12 hours max ang working hours nila.

When is the day off for each conductor and driver? Do they get to choose?

- Isang araw sa isang linggo ang day off nila, by coding ng designated jeep na ginagamit nila, ang trip planner ang nag rerecord at nag aayos ng schedule nila.

How much time or intervals does each modern jeep have between departs?

- 4:30 am ang start ng pag dating ng konduktors at driver. Ang interval is 10 minutes per labas ng jeep/10 minutes ang interval pag normal hours.
- Pag 6:00 am, ang interval is 5 minutes per labas ng jeep/5 minutes ang interval dahil rush hour.

What time does the modern jeep begin traveling, if they only make three trips in a day? Number of required trips, min? max? Gen policy on the number of trips?

- 4:30 am dumadating yung mga drivers at konduktor so pwede na sila mag start, depende sa driver kung papasok sya ng maaga or hindi dahil may dumadating ng 7 am, pero dapat makumpleto nila ang 3 trips para mag end ang shift nila so pag maaga kang pumasok maaga kang uuwi at kung late ka na, late ka den matatapos.
- 6 trips bale 3 trips na balikan from Calumpit to Meycauayan at pabalik. Yun lang ang maximum na trips na naka set. Bihira lang naman umabot don.

Other terminal for modern jeep? Except Calumpit?

- Sa Meycauayan but not total terminal na kagaya dito sa Calumpit na may opisina, may garahe lang ito for jeeps at pahingaan ng driver at conductor.

After they make three trips in a day, what they will do after that? If their shift has not ended yet?

- After three trips, end na ng shift nila, pwede na sila umuwi.

Is the modern jeep providing the proper discount to PWD, the elderly, and students?

- Yes, nakalagay iyon sa device option bago icompute ang total fare.

What if, sobra yung income nila for today na naireremit base sa records ng ticket, saan mapupunta yung sobrang income?

- pag may sobra ireremit pa din (other income reresibuhan)

Sino ang nag-aasign na personnel sa mga driver at konduktor, in terms sa gagamitin na jeep? Pwede bang papalit palit ng jeep?

- Trip planner, depende dahil each jeep ay may nakaassign na driver at conductor.

What if, nasira yung nakaassign na jeep sa driver for today, pwede ba syang gumamit ng ibang jeep? Example, nakaday-off yung nakaassign doon?

- Yes, but irerecord nila iyon. Pero kase yung day off ay depende nga sa coding ng jeep kaya yung pag papalit ay kung may sakit or ibang dahilan tulad ng di pumasok.

Ano pa ang ibang ginagawa ng mga konduktor?

- helper or kanang kamay ng driver in terms sa mga nangyayari sa loob at labas ng jeepney.

Meron bang inspector at required ito sa mga modern jeep? ano ang mga ginagawa nila?

- hindi naghihire ang company at hindi naman required depende sa policies and optional ito.

Fix partner ba ang konduktor at driver? yung device ba ay nakafix sa konduktor o sa jeep?

- depende sa policies ng company, hindi sila fix partner, nagkakapalit palit weekly or monthly to avoid corruption since hindi sila magiging magkaclose or magkasundo.
- depende sa unit ng jeep ang binibigay na gadget, nakafix ito sa jeepney hindi sa konduktor.

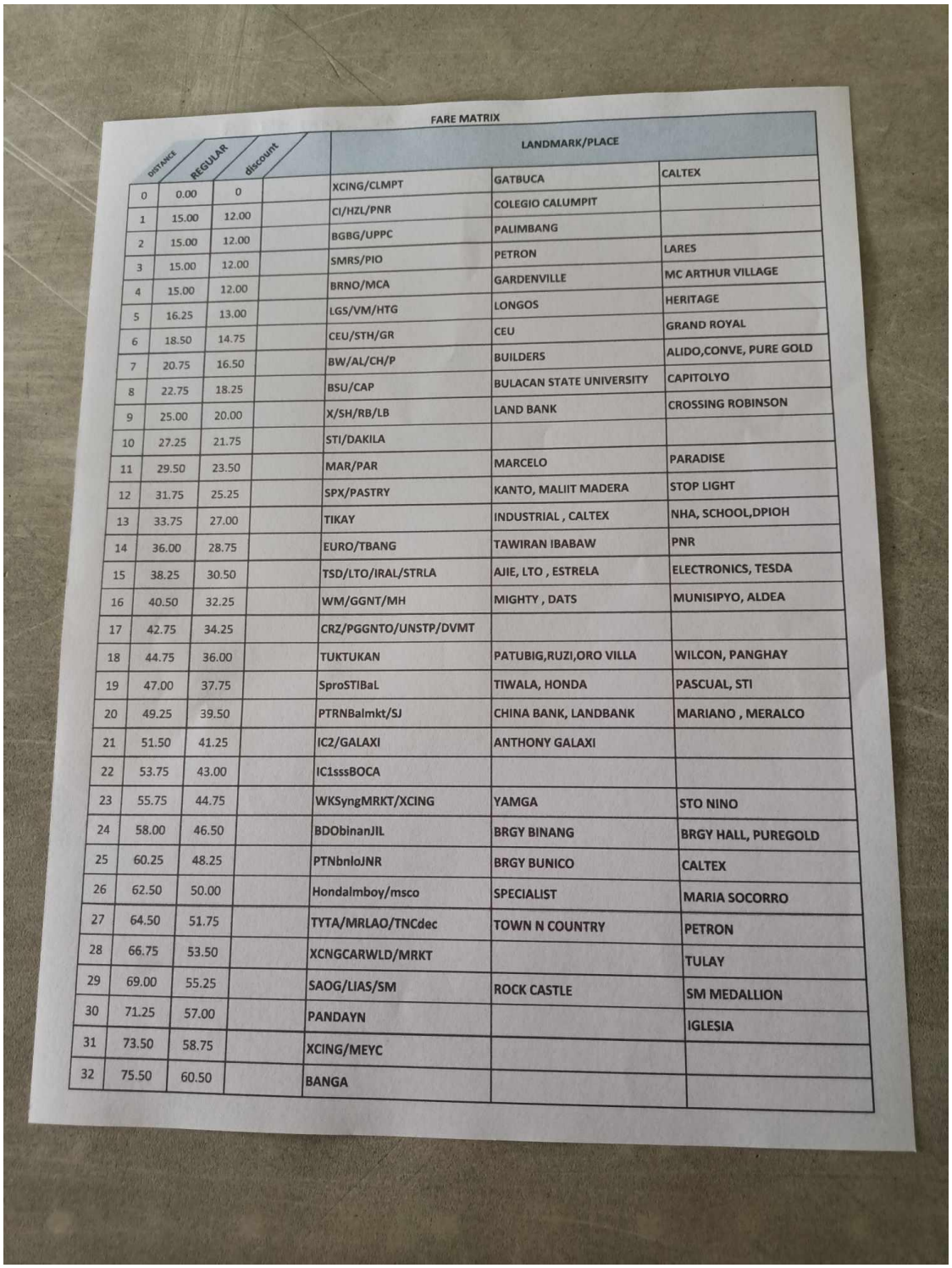
Nirerequire ba ang mag-accept ng beep cards? or hindi since AFCS?

- nag-aaccept ng beep cards pero hindi ito required, optional para sa mga pasahero, ang nirerequire sa company ay AFCS.

After itap ang beep card ano ang nangyayari?

- after tapping ng beep card ay may lalabas itong ticket, pero hindi pinapakita ang remaining balance ng card.
- direct sa bank ng company pag nagbayad using beep card.

Photos of the Interview



FARE MATRIX

DISTANCE	REGULAR	discount		LANDMARK/PLACE		
0	0.00	0		XCING/CLMPT	GATBUCA	CALTEX
1	15.00	12.00		CI/HZL/PNR	COLEGIO CALUMPIT	
2	15.00	12.00		BGBG/UPPC	PALIMBANG	
3	15.00	12.00		SMRS/PIO	PETRON	LARES
4	15.00	12.00		BRNO/MCA	GARDENVILLE	MC ARTHUR VILLAGE
5	16.25	13.00		LGS/VM/HTG	LONGOS	HERITAGE
6	18.50	14.75		CEU/STH/GR	CEU	GRAND ROYAL
7	20.75	16.50		BW/AL/CH/P	BUILDERS	ALIDO,CONVE, PURE GOLD
8	22.75	18.25		BSU/CAP	BULACAN STATE UNIVERSITY	CAPITOLYO
9	25.00	20.00		X/SH/RB/LB	LAND BANK	CROSSING ROBINSON
10	27.25	21.75		STI/DAKILA		
11	29.50	23.50		MAR/PAR	MARCELO	PARADISE
12	31.75	25.25		SPX/PASTRY	KANTO, MALIIT MADERA	STOP LIGHT
13	33.75	27.00		TIKAY	INDUSTRIAL , CALTEX	NHA, SCHOOL,DPIOH
14	36.00	28.75		EURO/TBANG	TAWIRAN IBABAW	PNR
15	38.25	30.50		TSD/LTO/IRAL/STRLA	AJIE, LTO , ESTRELA	ELECTRONICS, TESDA
16	40.50	32.25		WM/GGNT/MH	MIGHTY , DATS	MUNISIPYO, ALDEA
17	42.75	34.25		CRZ/PGGNTO/UNSTP/DVMT		
18	44.75	36.00		TUKTUKAN	PATUBIG,RUZI,ORO VILLA	WILCON, PANGHAY
19	47.00	37.75		SproSTIBaL	TIWALA, HONDA	PASCUAL, STI
20	49.25	39.50		PTRNBalmkt/SJ	CHINA BANK, LANDBANK	MARIANO , MERALCO
21	51.50	41.25		IC2/GALAXI	ANTHONY GALAXI	
22	53.75	43.00		IC1sssBOCA		
23	55.75	44.75		WKSyngMRKT/XCING	YAMGA	STO NINO
24	58.00	46.50		BDObinanJIL	BRGY BINANG	BRGY HALL, PUREGOLD
25	60.25	48.25		PTNbnloJNR	BRGY BUNICO	CALTEX
26	62.50	50.00		Hondalmboy/msco	SPECIALIST	MARIA SOCORRO
27	64.50	51.75		TYTA/MRLAO/TNCdec	TOWN N COUNTRY	PETRON
28	66.75	53.50		XCNGCARWLD/MRKT		TULAY
29	69.00	55.25		SAOG/LIAS/SM	ROCK CASTLE	SM MEDALLION
30	71.25	57.00		PANDAYN		IGLESIA
31	73.50	58.75		XCING/MEYC		
32	75.50	60.50		BANGA		

Fare Matrix from ChatCo

APPENDIX H. USER'S MANUAL

Touch Screen LCD

The passenger can choose their desired destination on the Touch Screen LCD. It will display the current balance, origin and other details from the card. The driver and conductor can also use this for attendance, select spare change, and selecting the bus number.

RFID Reader/Writer

The passenger will tap in their card in the RFID Reader/Writer for every transaction and tap out before getting off the e-jeep. The Master Key will be use to tap for attendance, loading and changing routes.

GPS Module

This module fetches the coordinates of longitude and latitude to locate the origin and destination of the passenger, as well as the E-jeep's location.

Mini Thermal Printer

It prints a receipt for every transaction. The receipt includes details such as the origin, destination, calculated fare, balance, load amount, discount, card type, date, time, and other information.

Buzzer

It provides guidance for each passenger's transaction: if the passenger heard one beep it indicates a successful transaction, while two beeps signal means a failed transaction.

LED

The green LED indicates that the device is ready to use or scanning for a card. If the tapping of card fails or there is an insufficient balance, then the red LED will turn on for one second along with sound of buzzer.

Attendance

The conductor and driver will tap their master key for attendance. If the conductor tap their master key they will choose their spare change. After submitting, the information will be saved to the database, then it will display an interface for the driver, they will tap their master key for attendance, and choose their bus number, after that it will save to the database along with the conductor's information.

Tap-In

The passenger will tap in their card, and it will display their origin, current balance, and destination. They will then select their destination and confirm the transaction then tap again to compute and pay for the transaction, so the mini thermal printer will print a receipt.

Tap-Out

The passenger will tap out their card if they reach their exact destination, then the transaction will end. But if the passenger gets off early or extends their destination, they will need to tap again to adjust the fare and print a receipt. If the passenger extends their trip and doesn't have enough money on their card, they will need to load using the master key.

Master Key

The conductor will tap his card, and it will display the transaction for Load and Change Route. If the conductor choose Load, then the passenger will need to enter the amount, confirmation the transaction, and print a receipt. If the conductor selects Change Route, he will submit the change route, and a receipt for all previous transactions will be printed.

APPENDIX J. CURRICULUM VITAE RESEARCHERS

Curriculum Vitae of

Jellah Bernadeth Y. Cabillo

P Castro St. Borol 1st, Balagtas, Bulacan
cabillojellah@gmail.com
09212822026

EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2021- present	STI College Balagtas
Vocational/Technical	2019-2021	Dr. Yanga's Colleges, Inc.
High School	2015-2019	Balagtas National Agricultural High School (Annex)
Elementary	2009-2015	Borol 1st Elementary School

PROFESSIONAL OR VOLUNTEER EXPERIENCE

Inclusive Dates	Nature of Experience/ Job Title	Name and Address of Company or Organization
N/A	N/A	N/A

Listed in reverse chronological order (most recent first).

AFFILIATIONS

Inclusive Dates	Name of Organization	Position
2021 - 2023	BALANI Organization	Member
2021 - 2023	ICPEP.se	Member

Listed in reverse chronological order (most recent first).

SKILLS

SKILLS	Level of Competency	Date Acquired

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
November 2023	STI Student Acceleration Training (Huawei)

Listed in reverse chronological order (most recent first).

Curriculum Vitae of

Marianne Mae DG. Escuton

162 Pulong Gubat Balagtas Bulacan
mariannemaeescuton@gmail.com
09554333785

EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2021-present	STI College Balagtas
TechVoc	2019-2021	Balagtas National Agricultural High School (Main)
High School	2015-2019	Balagtas National Agricultural High School (Main)
Elementary	2009-2015	Marciano C. Rivera Elementary School

PROFESSIONAL OR VOLUNTEER EXPERIENCE

Inclusive Dates	Nature of Experience/ Job Title	Name and Address of Company or Organization
2023	Production Crew	La Primera Pollo Inc. (LPPI)

Listed in reverse chronological order (most recent first).

AFFILIATIONS

Inclusive Dates	Name of Organization	Position
2021-present	ICpEP.SE	Member
2021-present	BALANI Organization	Member

Listed in reverse chronological order (most recent first).

SKILLS

SKILLS	Level of Competency	Date Acquired

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
November 2023	STI Student Acceleration Training (Huawei)

Listed in reverse chronological order (most recent first).

Curriculum Vitae of

Andrie John G. Rosales

Blk 13 Lt 11 Ph2 Northville 7 Malis, Guiguinto, Bulacan
andriejohnrosales0409@gmail.com
09273954040

EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2021- present	STI College Balagtas
Vocational/Technical	2015 - 2019	Guiguinto National Vocational High School (Annex)
High School	2015 - 2019	GNVHS (Annex)
	2019 - 2021	STI College Balagtas Senior High
Elementary	2009 - 2015	Malis Elementary School

PROFESSIONAL OR VOLUNTEER EXPERIENCE

Inclusive Dates	Nature of Experience/ Job Title	Name and Address of Company or Organization
N/A	N/A	N/A

Listed in reverse chronological order (most recent first).

AFFILIATIONS

Inclusive Dates	Name of Organization	Position
2021 - 2023	BALANI Organization	Member
2021 - 2023	ICPEP.se	Member
2019 - 2021	Batikan Science Club	Member

Listed in reverse chronological order (most recent first).

SKILLS

SKILLS	Level of Competency	Date Acquired
Microsoft Office Literate	Intermediate	2017

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
November 2023	STI Student Acceleration Training (Huawei)

Listed in reverse chronological order (most recent first).

Curriculum Vitae of

Marc Francis DS. San Miguel

Florante St. Panginay, Balagtas, Bulacan
Francissamiguel9@gmail.com
09918723780

EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2021- present	STI College Balagtas
Vocational/Technical	N/A	N/A
High School	2015-2019	Balagtas National Agricultural High
	2019-2021	School BNAHS (Annex)
		STI College Balagtas Senior High
Elementary	2009-2015	FBMS

PROFESSIONAL OR VOLUNTEER EXPERIENCE

Inclusive Dates	Nature of Experience/ Job Title	Name and Address of Company or Organization
N/A	N/A	N/A

Listed in reverse chronological order (most recent first).

AFFILIATIONS

Inclusive Dates	Name of Organization	Position
2021 - 2023	BALANI Organization	Member
2021 - 2023	ICPEP.se	Member
2019 - 2021	Batikan Science Club	Member

Listed in reverse chronological order (most recent first).

SKILLS

SKILLS	Level of Competency	Date Acquired

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop

Listed in reverse chronological order (most recent first).